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A VIABLE ALTERNATIVE TO THE MILITARY SURVIVORS BENEFIT PLAN (SBP)

Harold Thomas Hobbs

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THESIS

A VIABLE ALTERNATIVE TO THE MILITARY SURVIVORS BENEFIT PLAN (SBP)

by

Harold Thomas Hobbs

June 1975

Thesis Advisor: CDR. Thomas N.Tate

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SBP increases as the base amount increases above the minimum allowable base.

A life insurance plan yielding a lifetime stream of benefits comparable to the SBP was developed and the lifetime costs and benefits were estimated using the same rate of discount, initial base amounts, rates of inflation, and retirement ages as were utilized for the SBP study. The ratio of costs to benefits of the SBP and the life insurance plan were compared and conclusions regarding the advantages and disadvantages of each plan were drawn from the emperical results.

A Viable Alternative to the Military Survivors Benefit Plan (SBP)

by

Harold Thomas Hobbs
Lieutenant, United States Navy
B.S.E.E., University of Utah, 1968

Submitted in partial fulfillment of
the requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

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June 1975

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A life insurance plan yielding a lifetime stream of benefits comparable to the SBP was developed and the lifetime costs and benefits were estimated using the same rate of discount, initial base amounts, rates of inflation, and retirement ages as were utilized for the SBP study. The ratio of costs to benefits of the SBP and the life insurance plan were compared and conclusions regarding the advantages and disadvantages of each plan were drawn from the emperical results.

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I. INTRODUCTION

On 21 September 1972, Public Law 92-425 was signed by President Richard Nixon, thereby creating the "Survivor's Benefit Plan" (SBP) as a replacement for the Retired Serviceman's Family Protection Plan (RSFPP). This new plan is designed primarily to provide widows of service personnel, who are entitled to retired or retainer pay, with an income during the difficult period between the time the youngest dependent child leaves the family and the widow receives old age Social Security. The SBP also applies to dependents of retirees who would have no eligible widow, or to natural persons with an insurable interest in retirees who would have no eligible widow or dependent children.

Numerous articles and pamphlets have been written presenting the desirability and advantages of the SBP. Comparison with an alternative plan of life insurance reveals a number of features which may make the SBP less appealing than advertised. However, since there is a noticeable lack of literature describing these undesirable aspects, an objective decision concerning the plan is difficult for the prospective retiree to make. Therefore, it is the purpose of this paper to determine and examine the effects of some of these less desirable features on the SBP and present a viable alternative which lacks these undesirable features.

An analysis of costs and benefits was utilized to determine what options under the SBP will minimize the sum of the lifetime stream of costs to a retiree or maximize the sum of the lifetime stream of

benefits to the beneficiary. In addition, consideration was given to a life insurance plan which could be utilized in conjunction with, or as a substitute for, the SBP as a possible means of further reducing the sum of the lifetime stream of costs to a retiree for any particular stream of desired benefits.

II. CHARACTERISTICS OF THE SBP

Public Law 92-425, Subchapter II, title: "Survivor's Benefit Plan", applies uniformly to those personnel of the armed forces, the National Oceanic and Atmospheric Administration, and Public Health Service who are entitled to retired or retainer pay (hereinafter "retired pay" means "retired pay or retainer pay"). These personnel may provide an eligible widow or widower (or a dependent child or other natural person with an insurable interest) a monthly benefit of 55% of an elected "base" amount regardless of age or physical condition at the time of retirement. This "base" may range from a minimum of $300. 00 per month to a maximum of the full monthly amount of an individual's retired pay and it will be adjusted, automatically, to reflect increases in the Consumer Price Index (CPI) after retirement. Exception is made where the retired pay is less than $300. 00 per month, in which case the base amount must be the entire amount of retired pay.

The cost to a particular retiree varies according to the classification of his beneficiary and the base amount he elects. For spouse-only or child-only coverage, the monthly cost to guarantee any specific benefit will be 2-1/2% of the first $300. 00 of the elected base (i. e. , $7. 50) plus 10% of the base in excess of $300. 00. For

spouse and children coverage, the cost will be the same as for spouse-only coverage plus a modest additional actuarial charge (less than 1% of the base amount) dependent upon the retiree's age, the age of the spouse and the age of the youngest child. The additional actuarial charge will terminate when the youngest child is no longer an eligible annuitant (at age 18, or at age 22 if the child is a full time student at a recognized education institution). For coverage of a person with an insurable interest in the retiree, the monthly cost will be 10% of the entire base plus 5% for each full five years the beneficiary is younger than the retiree up to a maximum of 40% of the entire base amount. These costs will be adjusted to reflect increases in the CPI after retirement.

If a retiree desires his full retired pay to be used as the base amount and, therefore, provide an eligible spouse with the maximum benefit, he need take no action. The "automatic in" provision of the SBP provides the spouse with the maximum possible protection, automatically, unless the retiree elects otherwise in writing.

> Although the automatic-in provision calls for spouse-only protection to be based on a retiree's full pay, he can select a lesser amount to be used as the base amount or can decline to participate. However, a retiring member who selects a lesser amount, declines participation, or provides coverage only for a child (or children) when there also is an otherwise eligible spouse, must put that decision in writing at least 30 days before the first day he or she can receive retired pay.[1]

Regardless of the base amount eventually decided upon by a retiree, there are a number of factors which may reduce the benefit for a widow (hereinafter "widow" means "widow or widower") to less

---

[1] Survivor Benefit Plan, DOD PA-11, U.S. GOVERNMENT PRINTING OFFICE, 1973, pp. 7-8.

than 55% of that monthly base amount. Of particular interest is the fact that the benefit of a widow will be offset (reduced) after the widow reaches age 62 by the amount of social security benefits attributable to the retiree's military service. It should be noted that this offset will be instituted due solely to the fact that the widow is "entitled" to receive social security benefits due to the retiree's military service; whether these benefits are actually received, or not, is of no consequence. Additionally, and regardless of a widow's age, if there is only one child in the widow's care, the widow's share of the amount of a social security benefit attributable to the retiree's military service will be offset from the 55% annuity payable (approximately 50% of the social security benefit payable). Finally, the annuity will be completely terminated if a widow remarries prior to age 60, although payments will be resumed if that marriage is terminated. It should be noted that the cost to a retiree is not affected by any of the foregoing factors since they apply only to widows.

Two additional conditions of the SBP are considered of general interest. The first is:

> If a person who is married elects not to participate in the Plan at the maximum level, that person's spouse shall be notified of the decision. An election not to participate in the Plan is irrevocable if not revoked before the date on which the person first becomes entitled to retired or retainer pay.[2]

The second condition, which may be of extreme importance to prospective retirees, is:

---

[2] Public Law 92-425, Survivor Benefit Plan, Subchapter II, Section 1448 (a), 21 Sept. 1972.

> It is important to recognize that once an election to cover a spouse is made, that election is irrevocable, and the cost of coverage will continue for the life of the retiree even if the spouse predeceases the retiree.[3]

It should be noted that the decision to participate is also irrevocable in the case of divorce. Additionally, a beneficiary gained by remarriage of a retiree will not be eligible for benefits until married for two years, providing that the retiree initially elected to participate in the SBP upon retirement, although costs borne by the retiree continue throughout this two year period (these costs will actually be borne for the life of the retiree whether remarriage occurs or not).

Administrators of the SBP, retirees, and beneficiaries may not fully understand the ramifications of the preceeding characteristics of the SBP. In the opinion of the author, these characteristics demonstrate some extremely undesirable features of the SBP, many of which are probably non-quantifiable, which must be seriously considered by a prospective retiree prior to making a decision concerning this plan.

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[3] Uniformed Services Survivor Benefit Plan, NAVPERS 15180, Nov. 1972, p. 3.

III. THE DOLLAR COST OF BENEFITS

As previously shown, the cost to a retiree for a particular, spouse-only, benefit is computed from the base amount, and is 2-1/2% of the first $300.00 of the base plus 10% of the base in excess of $300.00. This cost amount, which is not considered taxable income, is withheld from the retiree's pay. The resulting monthly cost of the SBP, ignoring the time value of money, can be determined from the following equations:

$$\text{COST} = [\$7.50 + 0.1\,(B - \$300.00)] \quad \text{for } B \geq 300 \qquad \underline{\text{EQ. 1A}}$$

$$\text{COST} = [0.025\,(B)] \quad \text{for } B < 300 \qquad \underline{\text{EQ. 1B}}$$

where B is the base amount elected. The monthly benefit to be received by the widow will be 55% of the base amount unless the benefit is offset by the amount of social security payments the widow is entitled to as a result of the retiree's military service, as follows:

> If a widow has only one dependent child in her care, the amount of the mother's social security benefit attributable to the retiree's military service will be offset from the 55% annuity payable under this plan. The mother's share of the social security benefit in this case is just about 50% of the benefit payable. Additionally, after widow's age 62, where there are no dependent children to be cared for, the amount of the widow's social security benefit attributable to the retiree's military service will be offset from the 55% annuity . . . . The actual offset will be calculated by the Navy Finance Center, Cleveland, Ohio. . ..[4]

The benefit to be received, then, can be expressed by the following equations:

$$\text{BENEFIT} = [.55(B)] \quad \text{for widow age} < 62 \text{ and no dependent children} \qquad \underline{\text{EQ. 2A}}$$

---

[4] Uniformed Services Survivor Benefit Plan, NAVPERS 15180, Nov. 1972, pp. 3-4.

$\text{BENEFIT} = [.55\,(B) - 57]$ for widow age <62 and 1 dependent child. EQ. 2B

$\text{BENEFIT} = [.55\,(B) - 114]$ for widow age ≥ 62. EQ. 2C

where B is again the base amount elected.[5] These benefit amounts are also unadjusted for present value.

It is evident from above that both the cost of, and the benefits from, the SBP are computed as a percentage of the base amount elected. In no literature reviewed by the author was the cost of the Plan to a retiree expressed in direct relation to the benefit expected to be received. It can be readily as ascertained that the ratio of monthly costs to monthly benefits, unadjusted for the time value of money, will be at the minimum of:

$$\frac{\text{COST}}{\text{BENEFIT}} = \frac{7.50}{165.00} = .045+$$

or approximately 4.5% for the minimum ($300.00) base; and the ratio will approach a value of:

$$\frac{\text{COST}}{\text{BENEFIT}} = \frac{202.50}{1237.50} = .164+$$

or approximately 16.4% for the maximum theoretical retired pay based on 75% of $36,000.00 annually. The calculations of both these extremes ignore the effects of income tax, social security, the time value of money and inflation. Nonetheless, the interesting concern demonstrated

---

[5] Due to the complexity of determining the social security benefit attributable to military service for all of the various combinations of service connected pay and years of service at each pay grade, an "average" figure is used as the social security offset. The social security offset used in EQ. 2C was determined from the difference between benefits expected to be paid to widows before age 62 and after age 62 as shown in TABLE 15 of Senate Report No. 92-1089, p. 43 based on all military retirements on 31 Dec. 1972. The offset used in EQ. 2B is 50% of that used in EQ. 2C.

is that the cost increases at a more rapid rate than does the benefit for any chosen base greater than the minimum base. Additionally, although the minimum base amount of \$300.00 may be elected by a retiree so that he is participating at the level of the minimum ratio of costs to benefits, this ratio will in all probability increase automatically because of the effects from increases in the Consumer Price Index as explained in the next section.

IV. THE EFFECTS OF THE TIME VALUE OF MONEY

> Consumer Price Index (CPI) adjustments will be made to the base amount whenever and in the same manner that retired pay is increased (section 1401a of Title 10). The adjustments will increase both the cost to participate and benefits to survivors.[6]

The above quote and section 1401a of Title 10 of the U. S. Code both address the recomputations mandated to balance increases in the CPI. Since no mention is made of adjustments for decreases in the CPI, it is assumed that changes to existing legislation would be required to ever decrease the SBP cost or benefit variables. Thus, if these variables are changed at all due to CPI changes, they will be increased.

Although the CPI fluctuates from year to year, it can be seen from APPENDIX A that it has consistently increased over time. A "best fitting" exponential equation of the form:

$$Y = a_0 \quad e^{\lambda t} \qquad \text{EQ. 3}$$

(as determined by the "least squares" method) shows various rates of increase for the CPI over three separate periods of time. Each of

---

[6] Establishing a Survivor Benefit Plan for Members of The Armed Forces In Retirement And For Other Purposes, U.S. Senate Report No. 92-1089, 6 Sept. 1972, p. 50.

these rates represents a change in the base year used for comparison. An overall "best fitting" exponential equation determined by the historical CPI values from 1930 through 1974 yields the equation:

$$Y = 37.7\ e^{.0282t} \qquad \underline{\text{EQ. 4}}$$

where Y is taken as the discrete estimate of the CPI, as computed from the continuous equation above, for any particular year t (t= 0 at 1930). Although λ of EQ. 3 can take on positive or negative values of varying magnitudes, including zero, only values greater than or equal to zero (positive λ) need be considered as affecting SBP computations. Therefore, based on the historical plot of the CPI since 1930, a λ of .0282 appears to provide a reasonable estimate of a projected CPI. Since EQ. 4 can be shown to closely approximate an annual compound interest rate i,[7] it can be assumed that the CPI can reasonably be expected to increase at an annual compound rate of approximately 2.8%. However, regardless of the exact figures used, two generalities remain significant: (1) only increases in the CPI affect the SBP; and (2) over a long period of time, the CPI can reasonably be expected to increase.

Since costs for the SBP are paid, hopefully, for many years before a benefit will be received by anyone (the person paying the cost must die before a benefit can be paid out) the time-value of money becomes an important consideration in the determination of a realistic ratio of costs to benefits. The term "time-value" of money means the present value of that amount of money required, at some time in the future,

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[7] Refer to APPENDIX A for a more complete discussion of the accuracy with which the λ of .0282 approximates an interest rate.

to purchase an amount of goods equivalent to the amount of goods that can be purchased at present. Or, looking at it in another light, it may refer to the present value of the command that a given future benefit will have over goods. The present value of money may be thought of as an opportunity cost of not presently having an amount of money which is to be received in the future. Similarly, money paid out at present will not be available for investments which, if made, would increase the absolute amount of that money throughout future years. Since almost anyone in the United States can now obtain a 6% interest rate from money invested in U.S. Government Series E or H bonds (when held to maturity) or alternatively from relatively short-term certificates of deposit from savings and loan institutions or banks, 6% would seem to represent a fair opportunity cost of not having money at present. This may also be called a discount rate.

Although a sum of money invested at 6% will grow in absolute value in the future, the purchasing power of this money will be less than anticipated if inflation occurs. The effects of inflation are reflected in the purchasing power of consumers money through changes in the CPI index, which is one of the measures of an inflation rate. The present purchasing value (PPV) of money factor, for purposes of this paper, is determined by the combined effects of inflation and the discount rate and is given by:[8]

$$PPV = \frac{PV - CPI}{1 + CPI} \qquad \underline{EQ.5}$$

where PV is the present value discount rate, which is equated to an

---

[8] See APPENDIX C for a discussion of the present purchasing value of money factor (PPV) and the real present value of money.

interest rate on invested money (.06 for purposes of this paper) and CPI is the annual rate of increase of the Consumer Price Index, which, essentially, is a measure of inflation (hereinafter "inflation" means "CPI increases").

The monthly base amount elected by a retiree, his cost, and the benefit to be received from the Plan in "then year" dollars are shown in columns 2, 3 and 4 of TABLES B1 and B2 of APPENDIX B. A $300 base is assumed for TABLE B1 while annual inflation rates of 0.0, 1.5, 3.0 and 6% are considered. TABLE B2 considers the same inflation rates as above, but with a $450 base. The tables are intended to illustrate the important aspect that increases in the CPI trigger higher benefits, which are designed to offset the inflational erosion of the widow's buying power. The increased benefit, however, comes at a higher proportional cost, since all cost changes triggered by the CPI upswings are computed at 10% of the increased base. Therefore, the ratio of costs to benefits for any elected SBP level will be at its minimum the first year, and will increase with time as inflation occurs.

The effects of the real present value of money on the costs and benefits of the SBP can be seen by comparing columns 5 and 6 with columns 3 and 4 of TABLES B1 and B2 of APPENDIX B. The real present value of any cost or benefit shown in columns 5 and 6 decreases through time to values much lower than the "then year" dollar amounts shown in columns 3 and 4 of TABLES B1 and B2. This disparity increases as the time since retirement increases and, since benefits of the SBP will be received only after all costs have been incurred, the ratio of costs to benefits of the SBP will be much higher when considering the real present value of money than when considering

only "then year" dollars as in section III of this thesis.

V. THE SBP EXPECTED LIFETIME COST/BENEFIT RATIO

The lifetime cost of the SBP is the sum of all costs incurred by a retiree from the time of retirement until the retiree's death, adjusted for the time value of money including expected CPI increases. The expected lifetime cost of the SBP, for purposes of this paper, is the real present value of the future stream of lifetime costs that would be expected to be paid in the future for a representative population of retirees. A representative population of retirees means that the retirees are assumed to die at the same annual rate that they would be expected to die according to the CSO 1958 Standard Mortality Table's death rates, adjusted to an average, or per retiree, basis.

GRAPH 1 demonstrates the expected lifetime cost for persons who retire at any age from age 37 through age 65. The display was determined from COMPUTER PROGRAM 1 (COMPUTER PROGRAM 1 immediately follows APPENDIX C). The expected lifetime cost of the SBP is shown for $300, $450, and $600 bases unadjusted for the time value of money and inflation, and for a $450 base considering a 6% present value discount rate and potential future annual inflation rates of 0. 0, 1. 5, 3. 0, 4. 5, and 6. 0 (hereinafter "discount rate" means "present value discount rate").[9] As can be determined by inspection

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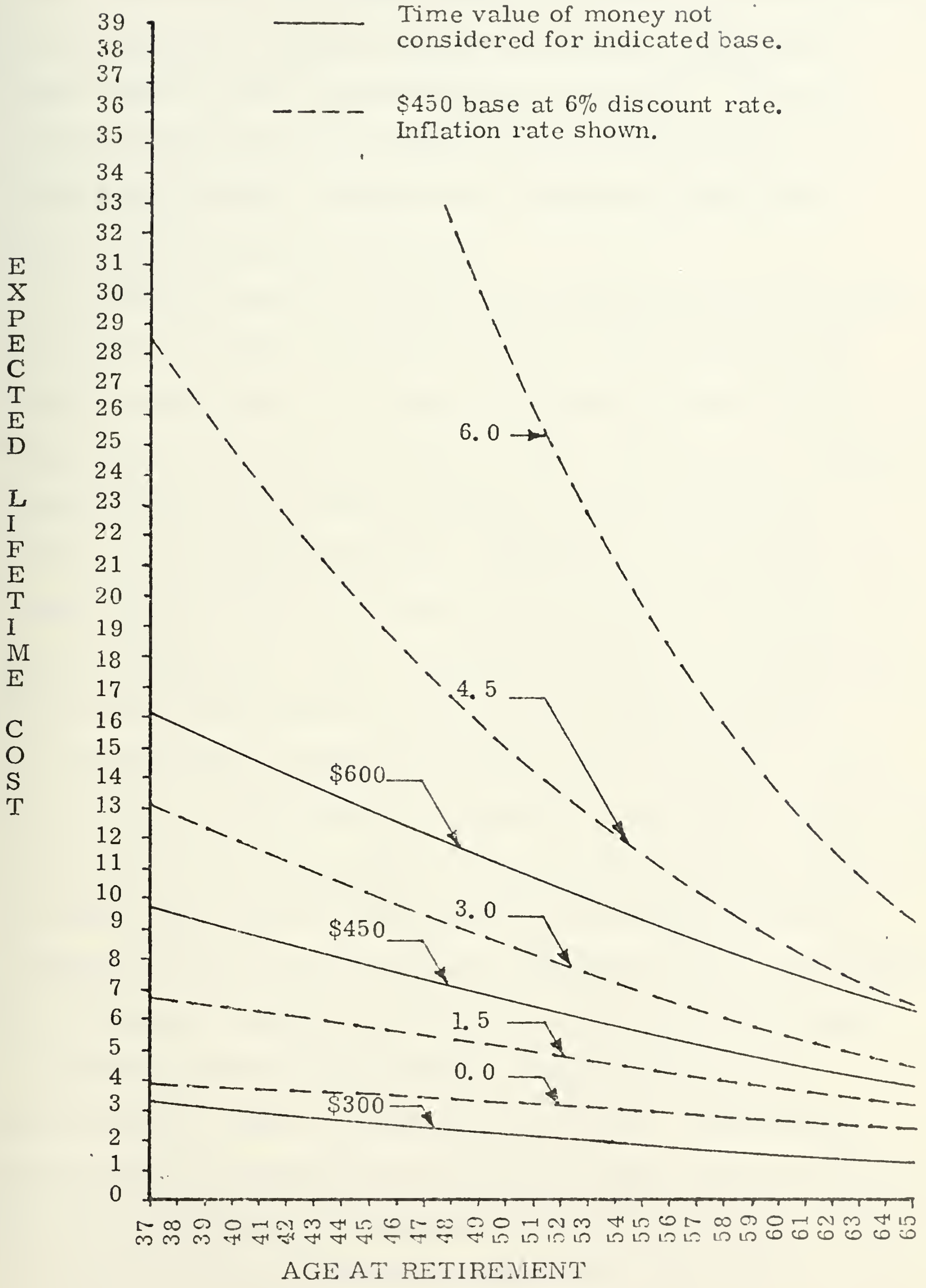
[9] A $450 base was chosen to demonstrate the effects of the assumed 6% discount rate and assumed inflation rates since the weighted average retired pay of all retirees as of 31 Dec. 1972 was $450. 72 according to the Committee on Armed Services, U. S. Senate Report No. 92-1089, Table 15, p. 43. The results of these same assumptions to $300, $600 and $750 bases demonstrated the same relationships of higher lifetime expected costs with increasing rates of inflation and for the lower ages of retirement.

SBP EXPECTED LIFETIME COSTS
(In Thousands of Dollars)

GRAPH 1



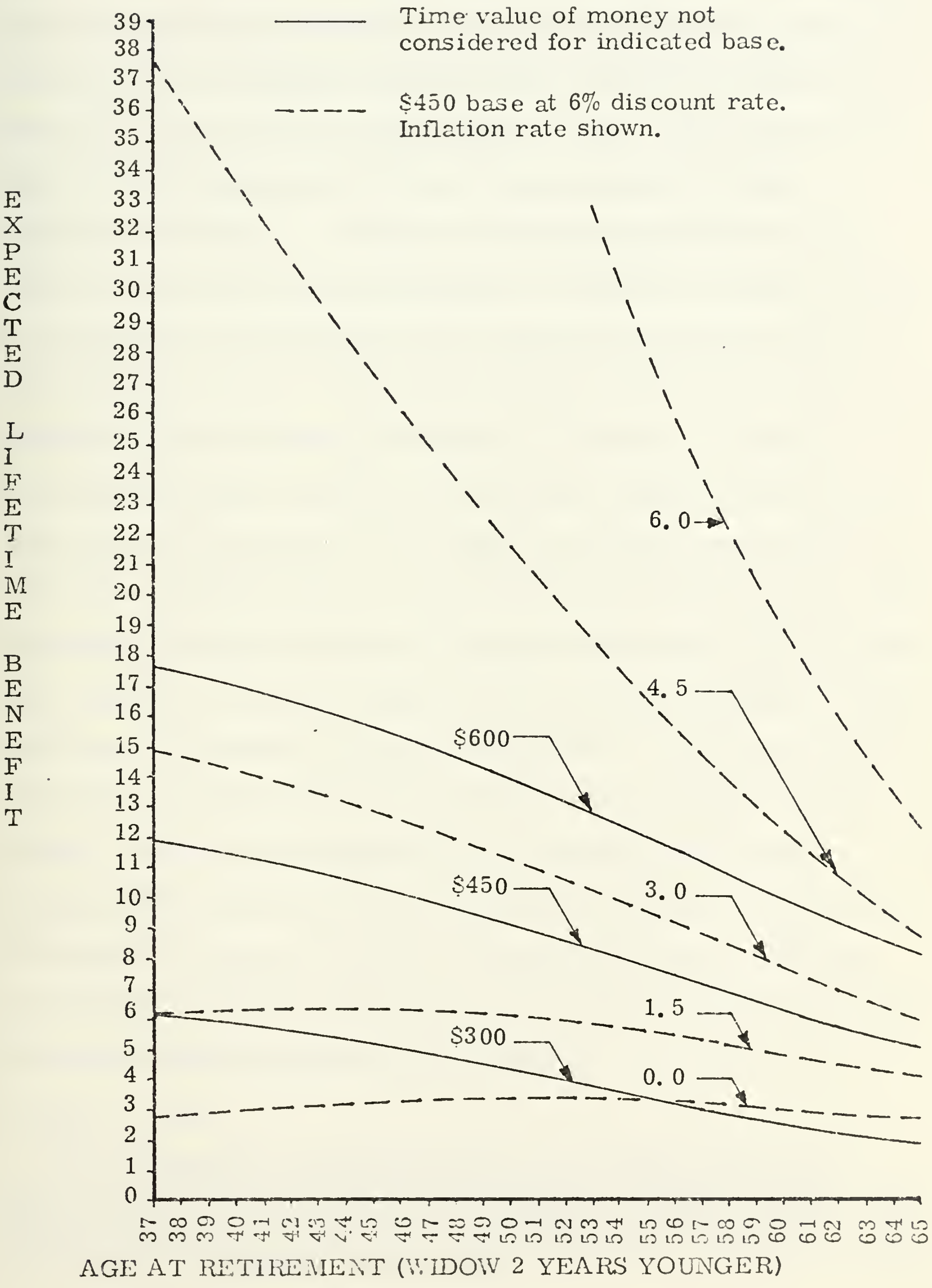
of GRAPH 1, the expected lifetime cost of the SBP is least for the lowest base amount, the lowest inflation rate and the maximum retired age. The expected lifetime cost will be higher for larger bases, larger inflation rates, and lower ages at retirement. The lowest expected lifetime cost at any discount rate for a person who retires at any age considered, results from the minimum possible base amount and minimum inflation rate.

The lifetime benefit of the SBP is the future stream of the benefits received by an eligible widow from the time of the retiree's death until the widow's death. Of course the possibility exists that the widow may predecease the retiree, in which case no benefit would be received (even though costs will continue to be incurred by the retiree, as previously discussed). Additionally, there will be a social security offset to this benefit at the beneficiary's age 62, as previously discussed. Thus, the expected lifetime benefit of the SBP, for purposes of this paper, is the sum of the real present value of the monthly lifetime benefits that would be expected to be received, in the future, for that portion of a population of potential beneficiaries that would actually be expected to receive benefits as determined from the death rates of both the retiree and the beneficiary population, reduced by the $114 S. S. offset at the beneficiary's age 62, and adjusted to an average, or benefit per widow of the initial population, basis.

GRAPH 2 demonstrates the expected lifetime benefits to be received by the widows of a population of retirees. The potential beneficiaries are assumed to be two years younger than the retiree in all cases and results are displayed for persons that retire at any age from age 37 through age 65 as determined from COMPUTER

SBP EXPECTED LIFETIME BENEFITS
(In Thousands of Dollars)

GRAPH 2



PROGRAM 1.[10] GRAPH 2 displays the expected lifetime benefits to be received for the same base amounts, discount rates, and inflation rates as assumed for GRAPH 1. As can be determined by inspection of GRAPH 2, the expected lifetime benefit of the SBP is least for the lowest base amount and the lowest inflation rate. This is essentially the same relationship observed in the expected lifetime costs displayed in GRAPH 1. The expected lifetime benefits do not necessarily decrease with an increasing age at retirement; however, as can be determined by the $450 base with a 6% discount rate and 0.0 or 1.5 annual inflation rates. This result is due to the fact that a number of potential beneficiaries may predecease the retiree. Of course a proportionally larger number will predecease younger retirees since all retirees are assumed to have eligible beneficiaries at the time of retirement. Additionally, with a positive assumed discount rate, time will affect the lifetime benefits of younger retirees more than those of older retirees. Thus, the expected lifetime benefits actually increase as the age at retirement increases beyond age 37. At the same time, the combined effects of the proportionally larger amount of benefits of older retiree's beneficiaries that are reduced by the social security offset and the fewer total number of years that benefits may be received increase as the age at retirement increases, gradually overcoming the effects of the discount rate and the proportional number of beneficiaries who predecease the retirees.

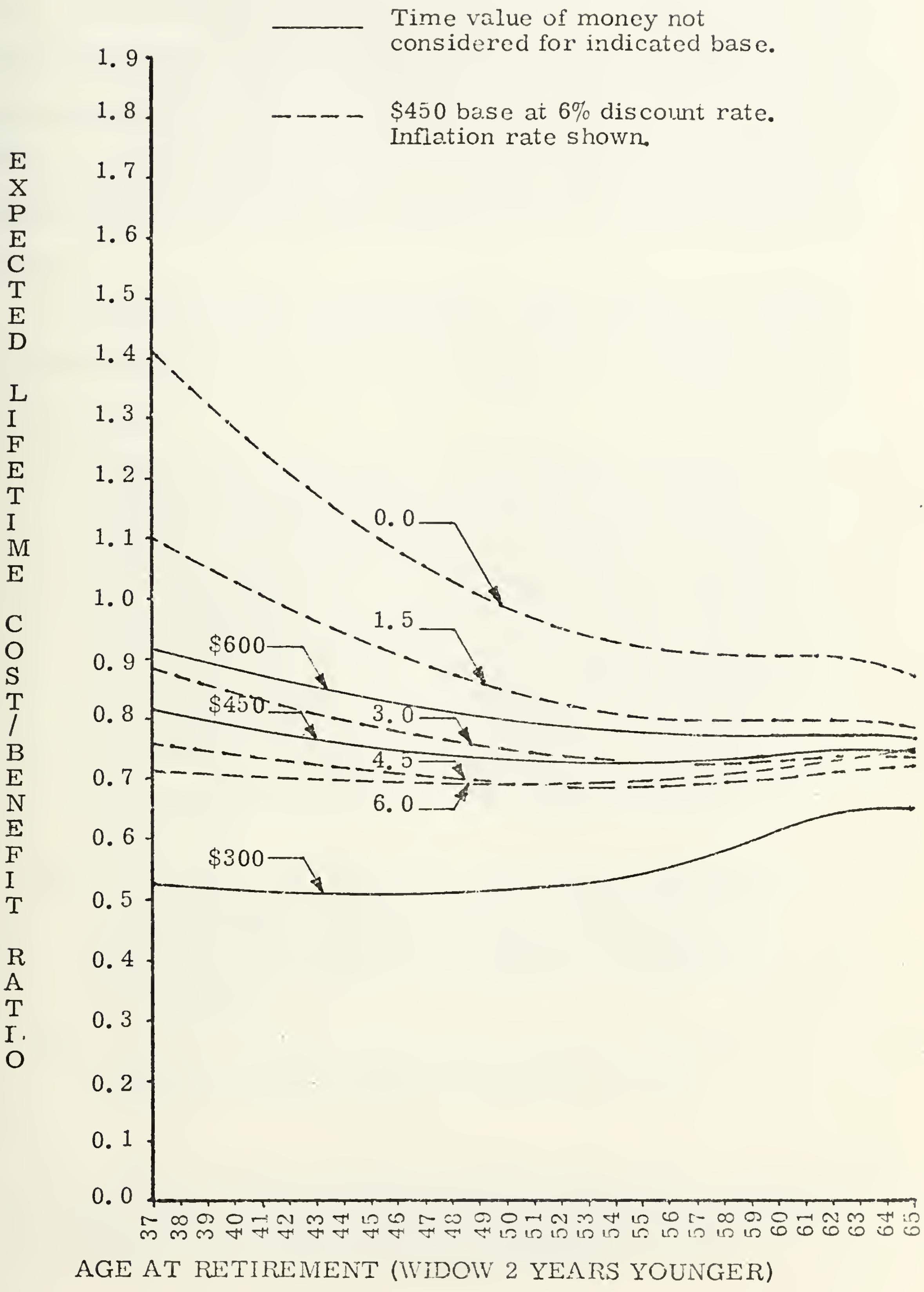
---

[10] The Committee on Armed Services, U.S. Senate Report No. 92-1089, Table 15, p. 43 lists 41.3 years as the weighted average age of all retirees and 39.1 years as the weighted average age of all retirees wives as of 31 Dec. '72. This differential of ages was rounded to two years for purposes of this paper.

A comparison of GRAPH 2 with GRAPH 1 demonstrates that different base amounts, an assumed discount rate, and different inflation rates all affect the lifetime expected benefits in much the same manner as they affect the lifetime expected costs of the SBP. A more direct method of comparison of the results of GRAPH 1 and GRAPH 2 can be obtained by determining an expected lifetime cost/benefit ratio for each age at retirement considered. The expected lifetime cost/benefit ratio for the SBP, means the total dollar amount of the expected lifetime cost for a given age at retirement, discount rate, and inflation rate divided by the total dollar amount of the expected lifetime benefit for the widow of a retiree with the corresponding age at retirement, discount rate, and inflation rate (hereinafter the "SBP cost/benefit ratio" means the "expected lifetime cost/benefit ratio"). Thus, an SBP cost/benefit ratio of 1.0 would indicate that the present value of the lifetime costs that would be expected to be paid by a retiree would equal the present value of the lifetime benefits that would be expected to be received by his widow. An SBP cost/benefit ratio of less than 1.0 would indicate that the benefits would exceed the cost and an SBP cost/benefit ratio of more than 1.0 would indicate that the costs would exceed the benefits.

The SBP cost/benefit ratios corresponding to the age at retirement, bases, discount rate, and inflation rates of GRAPH 1 and GRAPH 2 are displayed on GRAPH 3. The intent of GRAPH 3 is to demonstrate that the SBP cost/benefit ratio increases as the base is increased and, in all cases, is much higher than the unadjusted ratio of .164 demonstrated earlier in this paper. Additionally, GRAPH 3 demonstrates that

SBP COST/BENEFIT RATIOS



consideration of the 6% discount rate increases the SBP cost/benefit ratio while assumed inflation rates offset the effects of the discount rate. In fact, inflation rates slightly in excess of 3% reduce the SBP cost/benefit ratio to approximately the same as, or slightly less than, that obtained with a zero discount rate for a $450 base. Approximately the same result is obtained for all base amounts although the inflation rate necessary to offset the discount rate varies slightly according to the base.

Three factors which would affect the determination of the SBP cost/benefit ratio, but have not been included in this analysis, may be of interest:

(1) Costs of the SBP paid by a retiree are not considered ordinary income; however, benefits received by a widow are considered ordinary income for tax purposes. Thus, if the combined federal, state and local income tax rate applicable to a widow were known, the benefits to be received by that widow would be (1. 0 - tax rate) times the benefits as computed. This would result in an SBP cost/benefit ratio of 1.0/(1. 0 - tax rate) times the ratios as computed. For example, considering federal taxes only, a widow drawing a benefit of $247. 50/month (assuming a $450 base with no time value of money considerations) would pay federal taxes of approximately 17%.[11] Thus, the SBP cost/benefit ratio would be approximately 1. 2 times the appropriate ratio shown on GRAPH 3.

(2) Widows who remarry prior to age 60, and divorcee's, are not eligible to receive benefits. Thus, the total expected lifetime benefits may be considerably less than those computed in this analysis. The effect of this would be to increase the SBP cost/benefit ratios as computed.

(3) Widows with only one dependent child will receive benefits reduced by 50% of the social security

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[11] An annual income for single taxpayers of $2, 970 would be taxed at $310 plus 19% of $970 for a total of 16. 6% of the $2, 970 income, according to the 1974 Instructions For Form 1040, Internal Revenue Service, Department of the Treasury, Schedule X, p. 28.

benefit attributable to the retiree's military service. The effect of these reductions in benefits would be, again, to increase the SBP cost/benefit ratio as computed.

There are many alternative investments offering future income benefits to survivors. One alternative, a life insurance plan, will be examined and compared to the SBP in subsequent chapters of this thesis.

VI. AN ALTERNATIVE TO THE SBP

A program of life insurance would be a likely candidate for a reasonable alternative to the SBP. Since there are over 1,800 life insurance companies in the United States, there is a tendency for these companies to differentiate their product by providing unique plans of life insurance (i. e. , various mixes of ordinary life, life paid up at X years of age, steady term with increasing premiums, decreasing term with level premiums, family plans, accidental death benefits, etc.) which are available at widely varying rates depending upon which unique plan is chosen. This situation makes the determination of a viable life insurance program as an alternative for the SBP a very difficult task. A number of assumptions concerning premium payments and the types of policies utilized must be made in order to present a life insurance plan which would provide benefits of the approximate magnitude of those benefits which would be received from the SBP. Under the SBP, a widow receives one benefit (adjusted for CPI increases) until age 62 and an adjusted benefit thereafter (due to the social security offset). Thus, it would appear that an insurance plan which provides a particular benefit until age 62, and then decreases to a lesser amount, is a likely candidate for an alternative to the SBP.

For purposes of this paper, a linearly decreasing term insurance policy with constant premiums is elected to represent that portion of the SBP annuity which is lost when offset by social security. Assuming a retiree's widow would receive a monthly social security offset of $114 at age 62, the decreasing term policy must be of such a value as to provide a $114 monthly benefit from the time the retiree dies until the widow reaches age 62. At that time, the widow would receive the $114 per month from social security. As the widow gets closer to age 62, prior to the retiree dying, less insurance would be required to provide this monthly benefit.

For example, assuming the retiree would elect a $300 base, the widow's annuity would be $165 per month, $114 of which is termed the social security offset. In the alternative to the SBP being considered, this social security offset would be covered by decreasing term insurance until the widow's age 62, at which time social security provides the $114 per month to the widow. The remaining $51 portion of the SBP benefit ($165-$114) must be provided for the widow's entire remaining lifetime. An ordinary life insurance policy would appear to be a reasonable substitute for this portion of the SBP annuity. Thus, a life insurance plan, utilized as an alternative to the SBP, would involve a mix of decreasing term and ordinary life insurance. The amount of decreasing term insurance required would be determined by the amount of the widow's particular social security offset and her age at the time of retirement, while the amount of ordinary life insurance required would be determined by the amount required to provide the desired benefit in excess of the social security offset and the widow's age at the time of retirement. The

cost of such a plan would be the sum of the cost of the decreasing term policy and the cost of the ordinary life policy until the widow reaches age 62 at which time the cost of the decreasing term policy would cease. The annual cost of a particular policy, of course, would be determined by the age of the retiree, the face value of the policy, and the particular insurance company (and, thus, the premium rate) utilized. The lifetime cost to a retiree for an insurance plan would be the sum of all premiums paid from the time of retirement until the retiree's death. The expected lifetime cost of an insurance policy, for purposes of this paper, is the real present value of the stream of monthly costs of a particular policy (i. e. , ordinary life or decreasing term) that would be expected to be paid in the future, for each dollar of face amount of the policy, by a population of retirees that die at the same annual rate that they would be expected to die according to the CSO 1958 Standard Mortatlity Tables death rates, adjusted to an average, or per retiree, basis.[12]

GRAPH 4 demonstrates the expected lifetime cost to males, for each dollar for which they would insure their lives, beginning at any age from age 37 through age 65 as determined from COMPUTER PROGRAM 2. The expected lifetime cost per dollar of policy amount is

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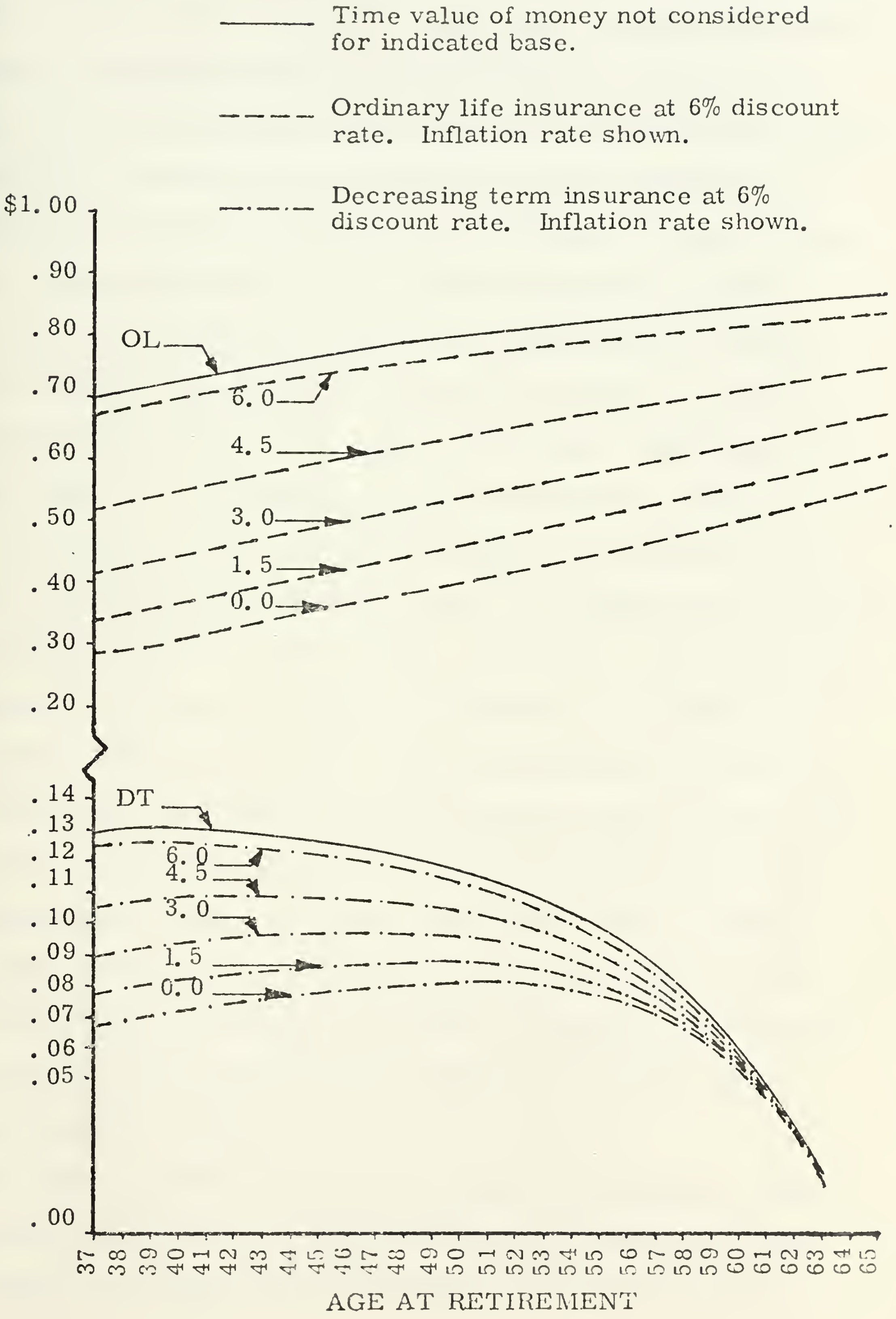
[12] Rates used for ordinary policies were determined from the average rate (at age 35) per $1,000 on a $10,000 non-participating policy of 85 life insurance companies and utilizing the rates of a company that listed that rate at that age (Government Employees Life Insurance Co. , Washington, D. C.) and utilizing its rates for all ages.

Average rates for decreasing term, level premiums, could not be readily determined; therefore, a company offering such a plan was arbitrarily chosen (Mutual Benefit Life Insurance Company, Newark, N. J.) and its rates per $1,000 on policies of $12,500 to $25,000 were utilized.

LIFE INSURANCE EXPECTED LIFETIME COSTS (Cost Per Dollar of Policy Amount) GRAPH 4



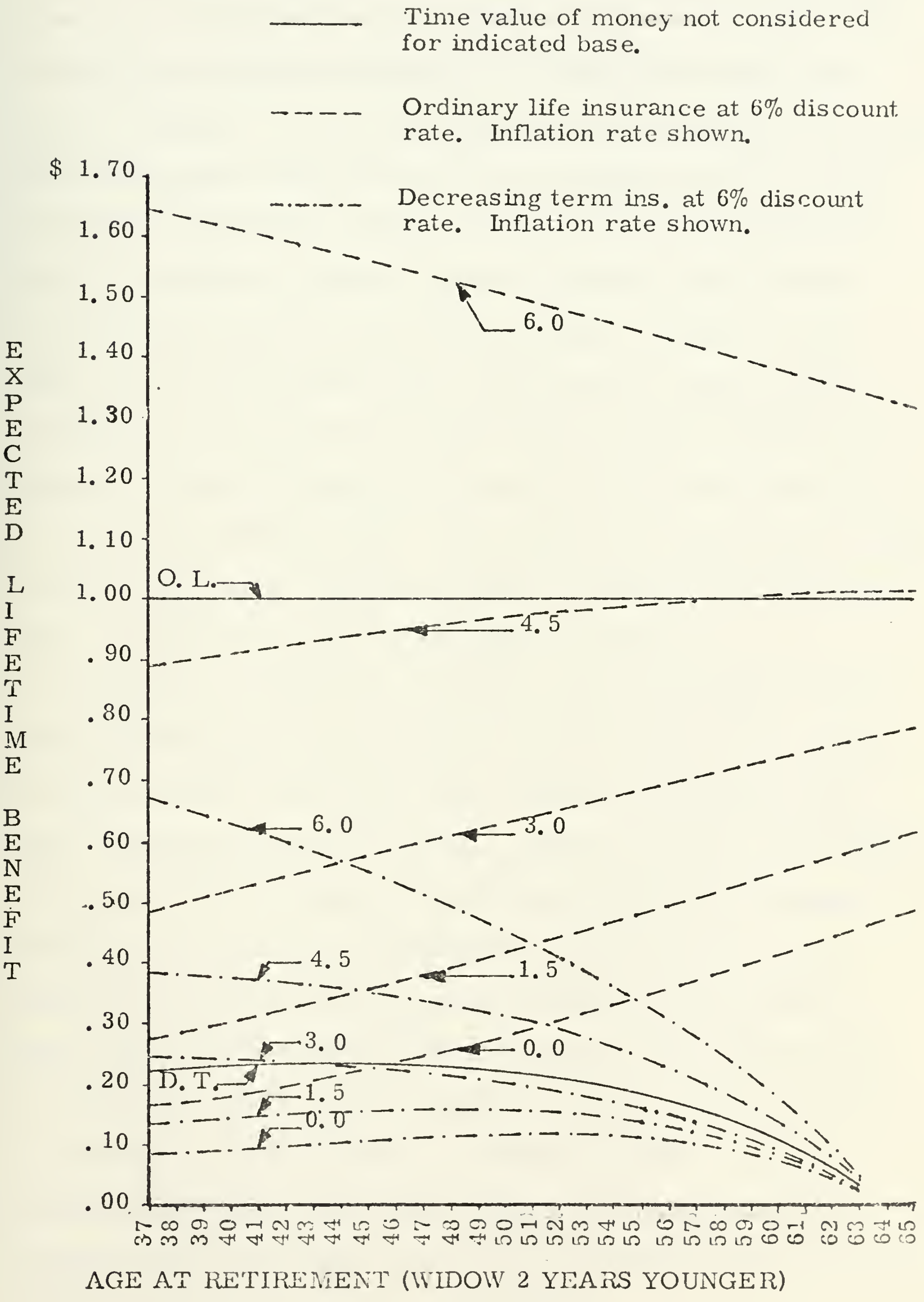
shown for an ordinary life and a decreasing term insurance policy with no discount rate or inflation and for a 6% discount rate with assumed inflation rates of 0.0, 1.5, 3.0, 4.5 and 6.0%. The beneficiary of all retirees is assumed to be 2 years younger than the retiree, thus, there would be no purchases beyond age 63 of the retiree (age 61 of the beneficiary). As can be determined by inspection of GRAPH 4, the expected lifetime cost of decreasing term insurance is much less than that of ordinary life insurance, as would be expected, since the premiums of decreasing term policies are generally much less per dollar of policy amount than for ordinary life policies and since the retiree would pay only through age 63, at the most. Additionally, it can be seen that an assumed discount rate reduces the present value of the expected lifetime insurance costs (hereinafter "life insurance costs" means "expected lifetime insurance costs"), assuming that the inflation rate does not exceed the discount rate. In general, the life insurance costs increase with increasing age of retirement for ordinary life insurance. These costs increase with increasing age at retirement for decreasing term insurance until the reduced number of years that these costs will be expected to be incurred overrides the increased rates applicable to increased ages at retirement. The preceeding discussion of life insurance costs dealt with costs per dollar of the insurance policy face amount, or benefit. The magnitude of the cost of an insurance plan, then, will depend upon the magnitude of each insurance policy utilized.

The direct benefits of a life insurance plan, as presented, would be the sum of the ordinary life insurance policy benefit and the remaining portion (if any) of the decreasing term insurance policy at

the time of the insured's (i. e., the retiree's) death. An indirect benefit may result since these benefits could be received in a lump sum payment. Thus, a large portion of the total benefit could be deposited in a savings account, or otherwise invested, and the return received on the invested amount would increase the magnitude of the benefit over time or, alternatively, the return could reduce the face amount of a policy required to produce a given benefit. Additional indirect benefits, which will be discussed in the following section of this thesis, may be realized from a life insurance plan as an alternative to the SBP.

GRAPH 5 demonstrates the expected lifetime benefits, for each dollar of insurance policy face value amount, to be received by beneficiaries that are assumed to be 2 years younger than their applicable male retiree, at the retiree's age when the policy is initially purchased, beginning at any age of retirement from age 37 through age 65 as determined from COMPUTER PROGRAM 2. The expected lifetime life insurance benefit (hereinafter "life insurance benefit" means "expected lifetime insurance benefit") per dollar of policy face amount, is shown for a decreasing term insurance policy with no time value of money considerations and for a 6% discount rate with assumed inflation rates of 0.0, 1.5, 3.0, 4.5 and 6%. Additionally, the assumption is made that, when the time value of money is considered, policy proceeds in excess of the amount required for 6 months increments of benefits are deposited (i. e., invested) for a 6% semi-annually compounded rate of return for the amount of time that a population of female beneficiaries would be expected to live according to the CSO 1958 Standard Mortality Table's

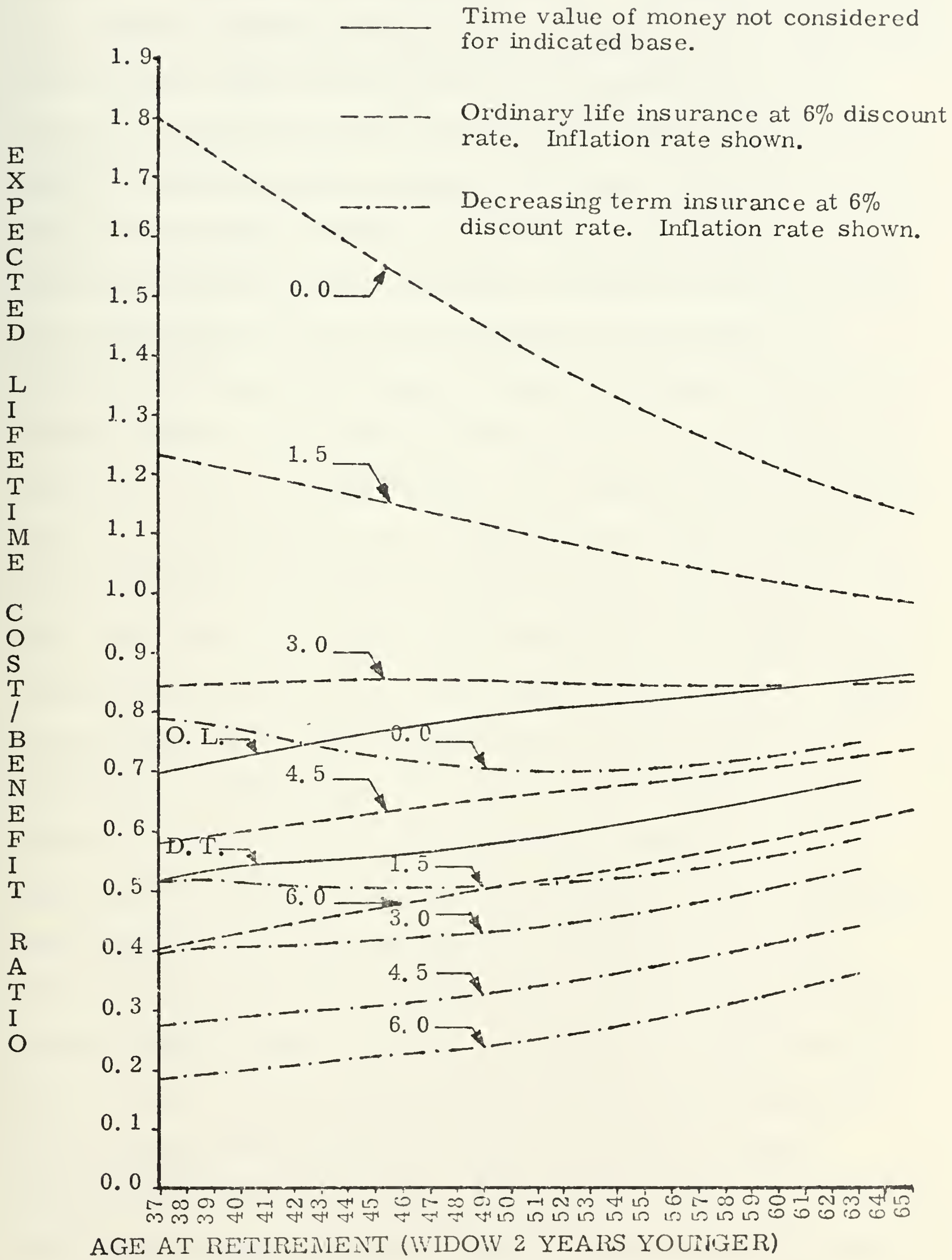
LIFE INSURANCE EXPECTED LIFETIME BENEFITS GRAPH 5
(Benefit Per Dollar of Policy Amount)



life expectancy, adjusted to an average, or per beneficiary, basis. As can be determined by inspection of GRAPH 5, the life insurance benefit expected to be received from an ordinary life insurance policy, with no time value of money considerations, is exactly the policy face amount, whereas, it is much less than the face amount for a decreasing term policy since a small portion of the population would be expected to receive a benefit from a policy which expired at the beneficiaries age 62. It can also be seen in GRAPH 5 that time value of money considerations affect the life insurance benefits in much the same manner as the life insurance costs were affected, with the notable exception that the real present value of life insurance benefits with an assumed discount rate may actually exceed the benefits expected to be received with no discount rate. This is due to the opportunity to obtain a rate of return on the invested portion of the benefit when a discount rate, or rate of return on an investment, is assumed.

The results of GRAPH 4 and GRAPH 5 can be utilized to obtain an expected lifetime cost/benefit ratio for life insurance (hereinafter the "life insurance cost/benefit ratio" means the "life insurance expected lifetime cost/benefit ratio"). The life insurance cost/benefit ratio has the same meaning as the SBP cost/benefit ratio displayed in GRAPH 3. It can be seen by inspection of GRAPH 6 that the life insurance cost/benefit ratio varies according to the time value of money for a particular age at retirement, but in all cases the ratio decreases for a particular age at retirement as the assumed inflation rate increases, much the same as it did for the SBP. The life insurance cost/benefit ratios apply equally to any amount of the respective type of insurance since the cost and benefit for a particular policy are linear with respect to policy size.

LIFE INSURANCE COST/BENEFIT RATIOS GRAPH 6



The effect of income taxes on the life insurance cost/benefit ratio has not been included in the analysis thus far. Costs paid by an insured are considered taxable income; however, benefits received from a lump sum insurance policy are not considered personal income for tax purposes. Any proceeds from an investment of this benefit, however, would be taxable as ordinary income. Thus, the cost of a life insurance policy, as computed, would be increased by the applicable tax rate of the insured and the benefit, as computed, would be reduced somewhat by the applicable tax rate of the beneficiary on that portion of the benefit received as a return on investment or the interest rate from a savings deposit. As an example of the tax effect on the life insurance cost/benefit ratio, a $26,000 ordinary life insurance policy purchased by a 37 year old retiree with a 35 year old wife would be intended to give the wife $133.50 per month benefit from her present age (for the most conservative case of the retiree dying in the first year) through her age 100 (the $133.50 per month benefit was chosen to correspond to that portion of the equivalent SBP benefit of $247.50 per month, attributable to a $450 base, that remains after the social security offset of $114 per month). For the first year of benefits, the wife would receive approximately $1,521 from interest, at 6% compounded semi-annually, on the unused portion of the $26,000 benefit. Her total annual benefit would be $1,602. Thus, approximately 95% of her benefit would be taxable. Of course, the ratio of the benefit received from interest to the total annual benefit received would decrease as the principal amount deposited decreases, eventually reaching approximately 3% at her age 100. Thus, on the average, her benefit will consist of approximately 50% taxable income and 50% non-taxable

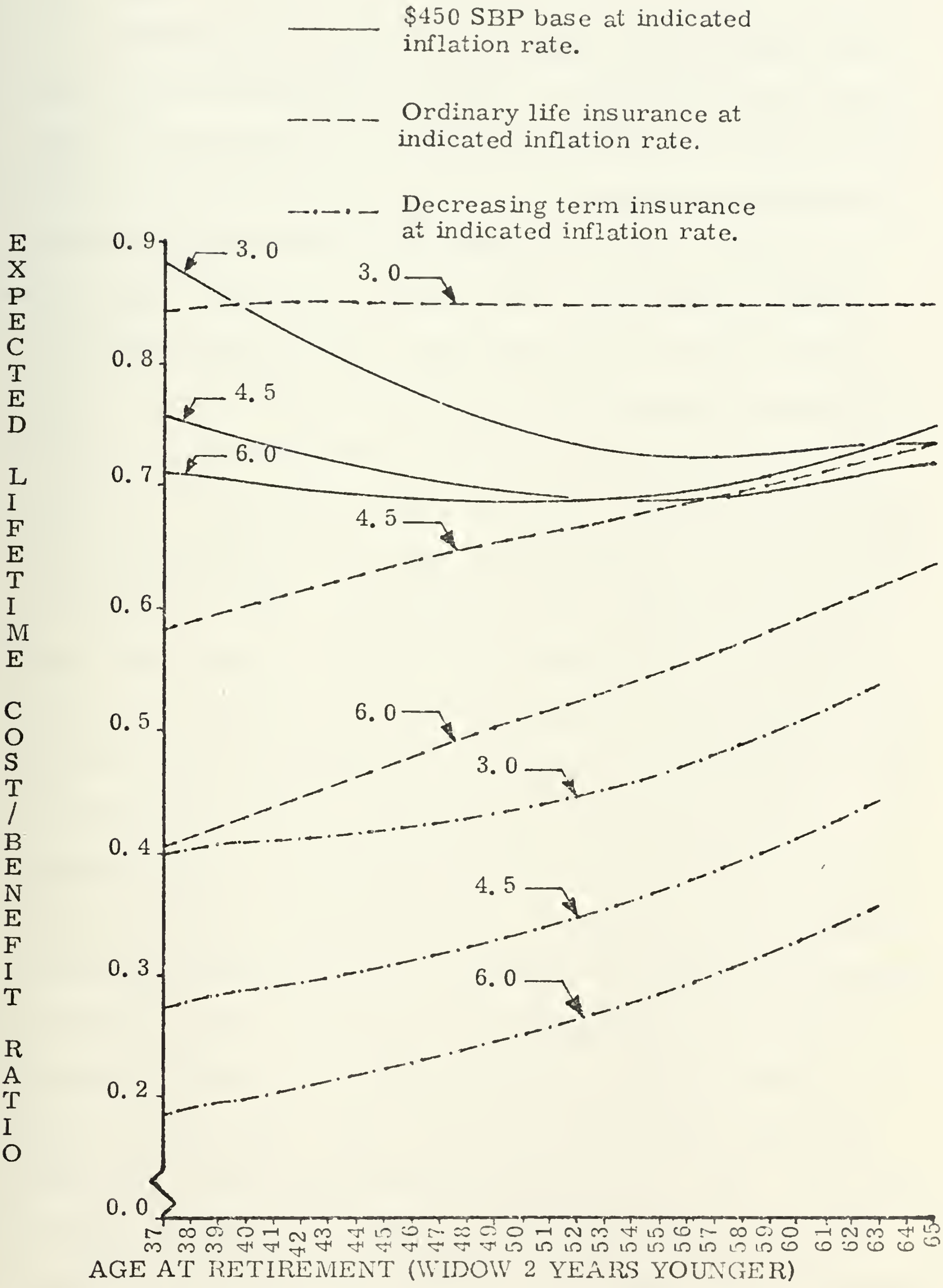
income. Assuming that her overall tax rate is approximately 16.6% (she is assumed to have the same total annual benefit as with a $450 SBP base) for her total income and half of that for 50% of that income, her tax rate attributable to the ordinary life insurance policy would be approximately 8.3%. Thus the life insurance benefit would be (1.0 - .033) or .917 times the benefit computed. Additionally, the life insurance cost will be 1.0 plus the retiree's lifetime income tax rate. Arbitrarily assuming a 25% income tax rate for the retiree, the life insurance costs will be 1.25 times those computed. The life insurance cost/benefit ratio will be increased to approximately (1.25/.917) or approximately 1.4 times those computed and shown in GRAPH 6.

VII. THE SBP AND LIFE INSURANCE COMPARED

The expected lifetime cost/benefit ratios of the SBP and ordinary life insurance, as shown respectively on GRAPH 3 and GRAPH 6, appear to be essentially comparable in magnitude. With a zero discount rate and no inflation, the SBP cost/benefit ratio, for a $300 base, is smaller than the ordinary life insurance ratio; however, for larger base amounts the SBP ratio becomes higher than that for ordinary life insurance. When the time value of money is considered, the SBP cost/benefit ratio is smaller in magnitude for low assumed inflation rates (i. e. , inflation rates less than 3%) but becomes larger than that for ordinary life insurance at higher assumed inflation rates. The ratio for decreasing term insurance is, in general, approximately the same as, or slightly smaller than, the ratio for the SBP at low assumed inflation rates, but becomes progressively smaller in relation to the SBP ratio as progressively higher inflation rates are assumed. The expected lifetime cost/benefit ratios for the SBP, ordinary life insurance, and decreasing term insurance are summarized graphically for assumed inflation rates of 3. 0, 4. 5 and 6. 0%, on GRAPH 7, in order to more clearly see the comparability of the SBP and ordinary life insurance ratios at the higher assumed inflation rates while also displaying the corresponding ratios for decreasing term insurance. As can be seen by inspection of GRAPH 7, the ratio for the SBP and ordinary life insurance are very close to each other for the lower assumed inflation rates, whereas, the ratio for ordinary life clearly is less at the higher (i. e. , 4. 5 through 6. 0%) assumed inflation rates, while the ratios for decreasing term insurance is lower

COST/BENEFIT RATIOS COMPARED (Assuming a 6% Discount Rate)

GRAPH 7



than either the SBP or the ordinary life insurance ratios throughout this range.

As discussed in section VI of this paper, a life insurance plan, utilized as an alternative to the SBP, would involve both ordinary life and decreasing term insurance in amounts of the same proportion to each other as the proportion of the social security offset to the total elected benefit of the SBP plan for which it would be a substitute. Thus, the magnitude of the actual expected lifetime cost/benefit ratio of such a life insurance plan would lie between the ratio for ordinary life insurance and decreasing term insurance for any assumed inflation rate. The location between these two points, for a particular age at retirement, would be determined by the proportionality of the social security offset to the total benefit elected for the SBP. As an example, for a population of members who retire at age 37, with an assumed inflation rate of 3.0%, the cost/benefit ratio for ordinary life insurance is approximately 0.85 and the ratio for decreasing term insurance is approximately 0.40. Assuming that this same population of retirees chose a life insurance plan to substitute for the SBP, and that they would have elected a $165 per month benefit (i. e., a $300 per month base) and that their beneficiaries would be entitled to a social security income of $114 per month, the ratio of decreasing term insurance to ordinary life insurance policy amounts to be utilized would be approximately 0.69. Thus, the insurance plan cost/benefit ratio applicable to this retired population would be .85 - [(.85 - .40) (.69)] or approximately 0.54. Thus, the cost/benefit ratio for the life insurance plan would nearly always be less than that of the SBP under

the assumptions made in this paper. A social security offset larger than the assumed $114 per month would not only increase the proportion of decreasing term insurance to ordinary life insurance, hence, reducing the cost/benefit ratio of an insurance plan, but it would simultaneously reduce the benefits computed in section V of this paper and, thereby, increase the cost/benefit ratio of the SBP. Of course, exactly the opposite effects would result from a social security offset of less than the assumed amount. Of the two extreme cases; that of no social security offset (which is not possible under existing legislation) whereby the applicable cost/benefit ratio would be that of ordinary life insurance or, that of a social security offset equal to the entire benefit whereby the applicable ratio would be that of decreasing term insurance, the latter case is much more probable for corresponding low SBP benefits (i. e., a $165/mo. benefit would be completely offset by a $165/mo. social security entitlement). Thus, a population of retirees would be expected to have an expected lifetime cost/benefit ratio very near the decreasing term insurance ratio of GRAPH 7 if a life insurance plan were elected as a substitute for the SBP and this resulting ratio would be much lower than the corresponding SBP ratio.

As discussed earlier in this paper, income tax effects on the cost/benefit ratios would be expected to increase the life insurance ratios more than the SBP ratios; i. e., the life insurance ratio would be increased on the order of 1. 4 times those shown on GRAPH 7 while the SBP ratios would be increased only on the order of 1. 2 times. Results obtained from calculations based on assumed divorce and marriage rates indicate that the possibility of ineligibility for benefits occurring due to widows remarrying prior to age 60, or

divorce, plus the possibility of a 50% social security offset applying to widows with only one child would increase the SBP ratios, as computed for a population of retirees to a value approaching or exceeding the 1.4 factor applicable to the life insurance ratios. The cost/benefit ratios as displayed in GRAPHS 3, 4 and 7 then, in the opinion of the author, fairly represent the relationships of ordinary and decreasing term life insurance to that of the SBP for a population of retirees representative of the average assumed populations upon which the computations were based.

The SBP cost/benefit ratios could be reduced in the near future as a result of potential legislative changes to the SBP. The federal civil service SBP, after which the military SBP is patterned, had an irrevocable cost feature, similar to that presently existing in the military SBP, until 1974. Legislation passed in 1974 allows civil service retirees to cease paying premiums when there is no longer an eligible beneficiary. Although equivalent legislation has not yet been proposed concerning the military SBP, such legislation will, hopefully, be considered in the near future. Legislation has been proposed (May, 1975) which would reduce the social security offset attributable to military service, from the present 100% offset, to 50%. This reduction of the social security offset would reduce the SBP cost/benefit ratios as computed, but not substantially. Legislation allowing the cessation of premiums when there is no beneficiary, however, would reduce the SBP cost/benefit ratios, as computed in this paper, by 20 to 25% in most cases.

VIII. SUMMARY AND CONCLUSIONS

Although the expected lifetime cost/benefit ratios of ordinary life and decreasing term insurance, and the SBP, as displayed on GRAPHS 3, 6 and 7, appear to show a life insurance plan in a favorable light compared to the SBP, the computations were based on a population of retirees , all of which were assumed to be representative of particular "norms" with respect to their life expectancy, their beneficiary's age and their beneficiary's life expectancy. It is improbable that a particular retiree within this population would fit all of these "norms" exactly. Thus, with the knowledge that a life insurance plan is comparable to, or possibly favorable to, the SBP from a cost/benefit ratio standpoint, for a population of "average" individuals, the basis for an intelligent decision concerning the plan exists. Utilizing the results of the cost/benefit ratio calculations, as they are applicable to a particular population of retirees, an individual retiree may make a decision concerning the level of, or the desirability of, participation in the SBP depending upon the degree of deviation from this population that he expects in the future and, of course, depending upon personal considerations.

As a further aid to making a decision concerning the SBP, some advantages and disadvantages of the SBP, as compared to a life insurance substitute, are summarized below:

Advantages of the SBP

1. A retiree may elect to participate regardless of age, physical condition, or insurability; thus, it is a desirable program for those unable to acquire life insurance at standard rates.

2. A widow is assured of a minimum income during her unremarried lifetime which will be adjusted upward by increases of the Consumer Price Index.

3. SBP premiums are deductible from ordinary income for federal tax purposes.

4. Premiums of $7.50 per month for the minimum base of $300, which would provide a $165 per month benefit, are extremely low.

5. Dependent children of, or in certain cases persons with an insurable interest in, retirees may be covered by the SBP; however, this coverage comes at additional cost and in the case of children applies only as long as eligibility is maintained.

Disadvantages of the SBP

1. Participation in the SBP at the maximum applicable base is automatic unless the base is reduced or participation in the plan is declined, in writing, at least 30 days prior to retirement.

2. Costs for the SBP will not be discontinued if the beneficiary predeceases the retiree or divorce occurs. The retiree will continue to pay premiums throughout his lifetime with no benefits paid to anyone; however, if the retiree remarries, his new wife will become eligible for benefits at the same level as those initially opted for (as adjusted by CPI considerations) after a two-year waiting period, or after a child is born of that marriage, whichever occurs first.

3. Remarriage of a widow who is collecting benefits, prior to her age 60, will terminate her eligibility for continued benefits.

4. The benefit of a widow with only one dependent child in her custody will be reduced by 50% of her social security entitlement due to her husbands military service.

5. The benefit of a widow will be reduced by 100% of her social security entitlement due to her husband's military service at her age 62. This entitlement, of course, will increase as social security benefits increase, thus, resulting in ever larger offsets with the passage of time.

6. Base amount increases resulting in a base in excess of $300, due to CPI increases, will result in cost increases of 10% of the increases base.

7. The SBP benefit is a monthly benefit only. It provides no estate. A widow requiring emergency or educational funds for children would have to look elsewhere.

8. SBP benefits are taxable as ordinary income to the beneficiary.

An additional disadvantage of the SBP, not listed above since it would not be a disadvantage to any particular individual, is that the plan is not actuarially sound. Benefits for year X are paid from premiums of year X. Any excess goes into general funds and any deficiency comes from general funds. Thus, in those years in which premiums paid into the plan exceed the benefits paid out, retirees are paying more than required to support the plan. In those years in which benefits paid out exceed the premiums taken in, the taxpayer is subsidizing the SBP.

Participation, non-participation, or level of participation decisions concerning the SBP are strictly individual decisions. In the author's opinion, participation in a life insurance plan is a viable alternative to the SBP, for a large number of potential retirees. Favorable action by Congress in the two potential legislature changes discussed in the previous section of this paper, however, would eliminate two of the more serious disadvantages of the SBP. Of course, if participation in the SBP is declined by a retiree, participation after the enactment of either, or both, of those legislative changes would not be possible without an additional legislative change to allow participation subsequent to retirement, thus, participation in the SBP at the minimum level, with a life insurance plan utilized to provide any additional desired benefits, would be a desirable course of action for many retirees.

APPENDIX A

The Consumer Price Index (CPI) was instituted in 1919, with previous data being utilized to compute indices for each year back to 1913. The index, in essence, was devised as an indicator of the dollar's purchasing power for a select group of consumers in key geographical locations, buying particular consumer items. The original index demonstrates, from 1913 through 1929, the amount of money required in each year to purchase the same given set of goods. For comparative purposes, the CPI for the base year 1919 was set at 100. As time passed, technology improved creating better items and more appealing substitutes, consumer preferences and attitudes changed, the population became more mobile, and consumer earnings increased. It soon became apparent that the 1919 CPI was no longer indicative of the true change in consumer's purchasing power. Therefore, a revision to the CPI was made in 1934. This version was utilized from 1930 to 1949, with 1934-36 being the base year. Similar situations have caused further revisions of the CPI, once in 1952 (covering the period 1950-1963), and once in 1964 (covering the period 1964-present). As each revision has been made and new base years established, all previous index values have been "normalized" to the new base year, making it possible to compare values for every year from 1913 to the present.

GRAPH A1 gives a graphical display of all the "normalized" annual CPI values from 1934 through 1974. For each of the base periods (i. e., 1930-1949, 1950-1963 and 1964-present) a least

squares curve was generated to fit the historical CPI data in order to determine the change of CPI over time. After trials with forms of straight lines, parabolas and exponentials, the exponential curve was determined to provide the most desirable estimating relationship. In addition to giving the lowest standard deviation of the historical data from the curve, this form also yields a rate of change which can be easily determined and understood. A single least squares expotential curve was also calculated for the combined periods from 1930 to the present, thereby providing a single realistic rate of change for the CPI over time.

The exponential that resulted is of the form:

$$Y = A_o e^{\lambda t} \qquad \text{EQ.A1}$$

where Y is the CPI (ordinate), A_o is a constant determining the starting point for each period, λ is the overall long-term rate of increase for the curve, and t is the year (abscissa) being considered (where $t=0$ for the first year of each period and increases by 1 each year throughout the period). The method of least squares utilizes an equation of the form:

$$Y_1 = a_o + a_1 X \qquad \text{EQ. A2}$$

where X and Y are historical data points.

To obtain a least squares curve from EQ. A1, the first order of business is to convert it to the form of EQ. A2. This can easily be done by taking the natural logarithm of both sides of EQ.A1. The result is:

$$\ln(Y) = \ln(A_o e^{\lambda t})$$

which is equivalent to:

$$\ln Y = \ln A_o + \lambda t \qquad \text{EQ. A3}$$

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which is equivalent to:

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where $\ln Y = Y_1$, $\ln A_o = a_o$, $\lambda = a_1$, and $t = X$. Since EQ. A1 is now in the form of EQ.A2, a_o and a_1 can now be found by application of the least squares line equations. By simple conversions, the original A_o and λ of EQ. A1 may be computed from a_o and a_1.

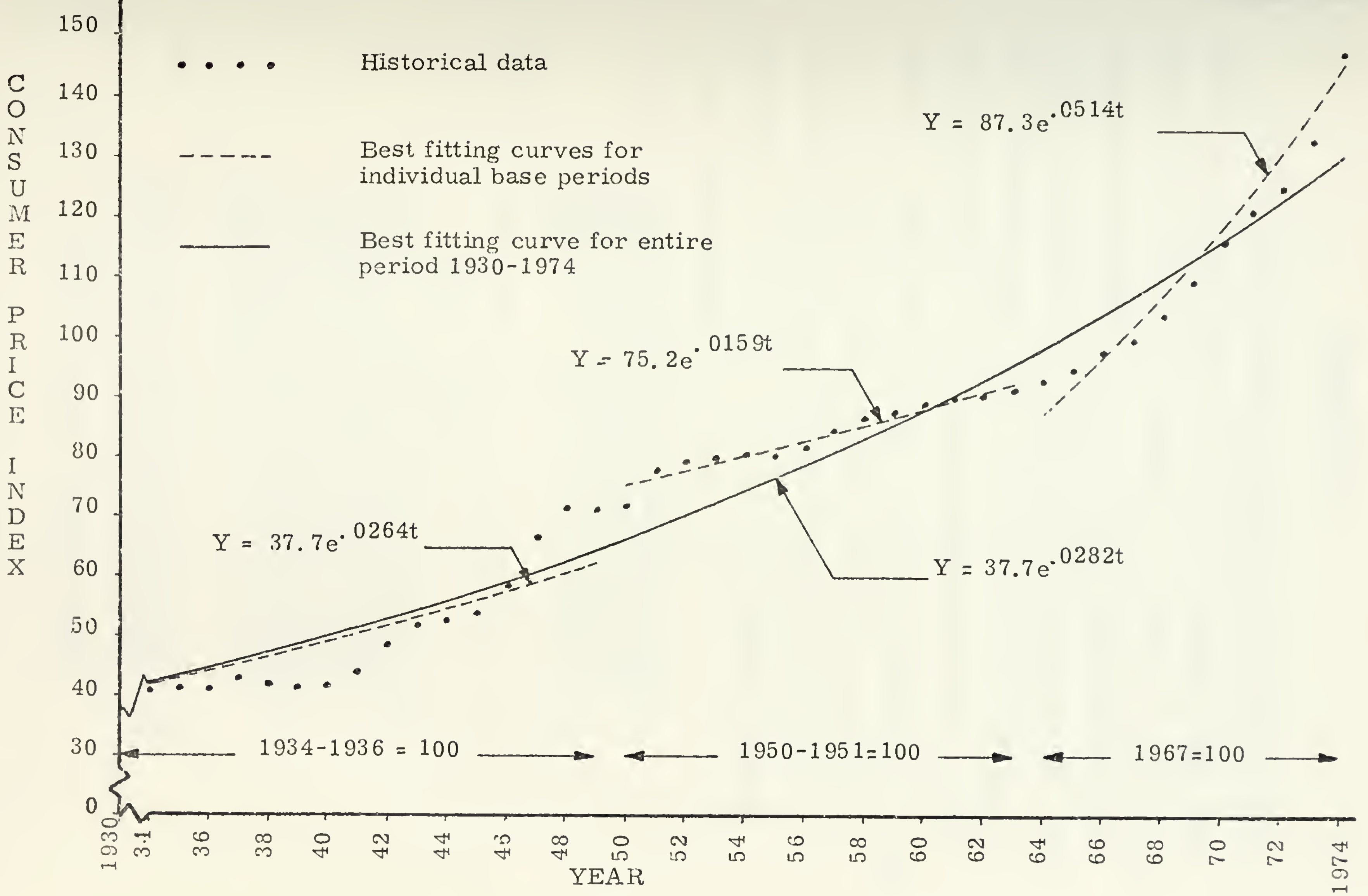
Correlation and variance of these estimates were not determined due to the fact that the equations are used only to determine a reasonable estimate of the historical change in CPI; thus, this was a deterministic rather than a predictive exercise. Any attempt to predict an expected future CPI would be of little value, since great uncertainty surrounds its behavior.

EQ. A1 closely approximates the compound interest formula, $A = p(1 + i)^n$ or $Y = a_o\ (1 + i)^t$, for small values of λ. Let $\lambda = \ln(1 + i)$ then $(1 + i) = e^{\lambda}$ and $(1 + i)^t = e^{\lambda t}$ and the compound interest formula $Y = a_o\ (1 + i)^t$ becomes $Y = a_o e^{\lambda t}$. The solid line of GRAPH A1 represents the exponential equation $Y = 37.7e^{.0282t}$ and λ for this equation is .0282. Thus, letting $.0282 = \ln(1 + i)$, it can be seen that $i = .0286$. EQ. A1, then, can be approximated by the compound interest formula with sufficient accuracy for purposes of this thesis.

The broken lines of GRAPH A1 are graphic representations of the exponential equations arrived at for each of the three periods (1930-1949, 1950-1963 and 1964-1974). The solid line on GRAPH A1 is a graphic representation of the exponential equation determined from all the historical CPI values from 1930 through 1974.

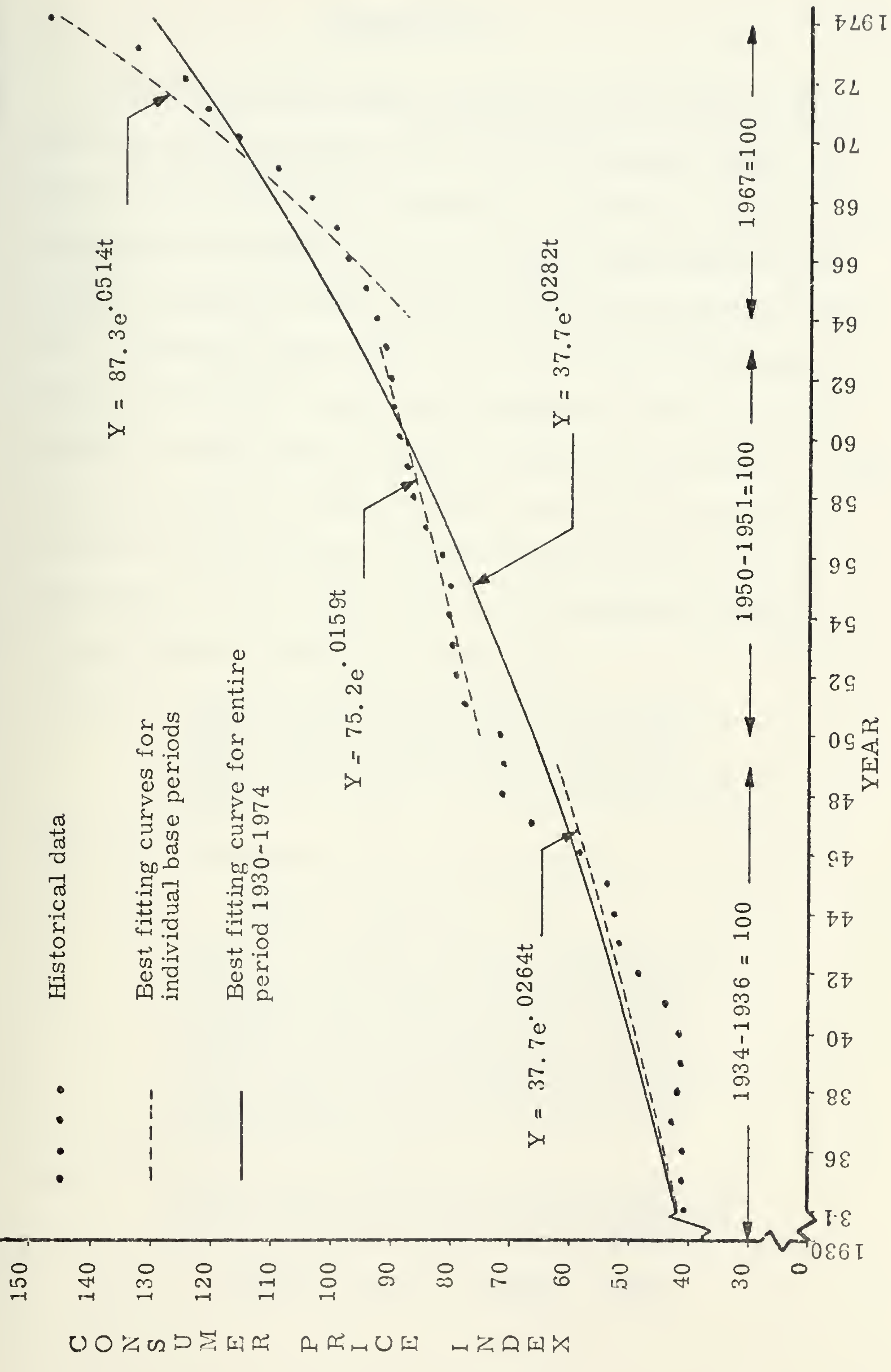
GRAPH A1

HISTORICAL CPI TRENDS



GRAPH A1

HISTORICAL CPI TRENDS



APPENDIX B

TABLES B1 and B2 of this Appendix trace the effects of CPI increases and the present value of money on the base, cost, and benefit of two typical SBP elections (i. e. , a \$300 and a \$450 base). Provided in the various columns are the n^{th} year amount that the original monthly base then represents, the n^{th} year monthly dollar cost (and present value of this cost at year 0) and the n^{th} year benefits (and present value of these benefits at year 0) all disregarding the social security offset occurring at wife's age 62. These various elements are shown for year 0 (the year of retirement) through 40 future years for each of 4 assumed annual rates of inflation (0. 0, 1. 5, 3. 0 and 6. 0%). The method of calculation for each column is further discussed below.

Col. 1 - Year 0 corresponds to the year in which a person retires, regardless of age in that year. Each number after 0 represents the number of years of participation in the plan.

Col. 2 - The compound interest equation is:

$$BASE_n = BASE_o (1.0 + i)^n$$

where i is the annual rate of inflation (0.0, 1. 5, 3. 0 or 6. 0%), n is the year being considered and $BASE_o$ is the base amount originally elected at retirement. This formula is used to determine the adjusted monthly base amount which will be used in a future year n to compute the cost and benefit for that year.

Col. 3 - This column demonstrates the monthly dollar cost in year n for the base corresponding to that year shown in Col. 2. The equation:

$$COST_n = [7.50 + .1 (BASE_n - 300)]$$

is used for each year. The cost savings due to favorable income tax treatment is not considered. If the income tax rate were known, then each cost figure could be multiplied by the factor (1.0 - TAX RATE) in order to determine the actual cost to the individual for that year.

Col. 4 - This column gives the monthly benefit to be received by a widow following the death of the retiree. This benefit can begin in any year, n, including the year of retirement (year 0). The equation utilized for these computations is:

$$\text{BENEFIT}_n = 0.55\ \text{BASE}_n$$

This column is not applicable to a beneficiary age 62 or greater.

Col. 5 - This column represents the year 0 real present value (RPV) of the monthly cost shown in Col. 3 for year n utilizing the present purchasing value (PPV) factor.* The equation utilized for these computations is:

$$\text{COST(RPV)} = \text{COST}_n / (1.0 - \text{PPV})^n$$

where

$$\text{PPV} = \frac{\text{PV} - \text{CPI}}{1 + \text{CPI}} = \frac{.06 - (.00,\ .015,\ .03,\ \text{or}\ .06)^*}{1 + (.00,\ .015,\ .03,\ \text{or}\ .06)}$$

and n is the particular year being considered.

Col. 6 - This column demonstrates the year 0 real present value (RPV) of the monthly benefit (shown in Col. 4), considering the present purchasing value (PPV) factor.* The equation utilized for these computations is:

$$\text{BENEFIT (RPV)} = \text{BENEFIT}_n / (1.0 + \text{PPV})^n$$

where, again,

$$\text{PPV} = \frac{\text{PV} - \text{CPI}^*}{1 + \text{CPI}}$$

This column is not applicable to a beneficiary age 62 or greater.

is used for each year. The cost savings due to favorable income tax treatment is not considered. If the income tax rate were known, then each cost figure could be multiplied by the factor (1. 0 - TAX RATE) in order to determine the actual cost to the individual for that year.

Col. 4 - This column gives the monthly benefit to be received by a widow following the death of the retiree. This benefit can begin in any year, n, including the year of retirement (year 0). The equation utilized for these computations is:

$$\text{BENEFIT}_n = 0.55\ \text{BASE}_n$$

This column is not applicable to a beneficiary age 62 or greater.

Col. 5 - This column represents the year 0 real present value (RPV) of the monthly cost shown in Col. 3 for year n utilizing the present purchasing value (PPV) factor.* The equation utilized for these computations is:

$$\text{COST(RPV)} = \text{COST}_n / (1.0 - \text{PPV})^n$$

where

$$\text{PPV} = \frac{\text{PV} - \text{CPI}}{1 + \text{CPI}} = \frac{.06 - (.00,\ .015,\ .03,\ \text{or}\ .06)^*}{1 + (.00,\ .015,\ .03,\ \text{or}\ .06)}$$

and n is the particular year being considered.

Col. 6 - This column demonstrates the year 0 real present value (RPV) of the monthly benefit (shown in Col. 4), considering the present purchasing value (PPV) factor.* The equation utilized for these computations is:

$$\text{BENEFIT (RPV)} = \text{BENEFIT}_n / (1.0 + \text{PPV})^n$$

where, again,

$$\text{PPV} = \frac{\text{PV} - \text{CPI}^*}{1 + \text{CPI}}$$

This column is not applicable to a beneficiary age 62 or greater.

A comparison of Col. 5 with Col. 6 will demonstrate an interesting phenomena. Under the SBP, a retiree pays the cost of the plan from retirement (year 0) until his death. The benefit payable to a retiree's widow will commence only at that year (retiree's death year) and will continue until the widow dies, assuming the benefit is not reduced for any of the reasons discussed in section II of this paper. The year 0, real present value (RPV) of a retiree's total lifetime costs will be approximately twelve times the sum of all the monthly RPV benefits listed from the year of the retiree's death until the year of his widow's death.* Due to the fact that the present purchasing value factor has an ever greater effect as time increases beyond year 0, it will affect the benefit variable much more than the cost variable. * This coupled with the fact that the benefit will be offset by some amount at the widow's age 62 causes the benefit to decrease more rapidly (for low rates of inflation) or, increase less rapidly (with high rates of inflation) than the decreases or increases in the total lifetime cost variable.

---

* See Appendix C for a discussion of the present purchasing value factor utilized.

TABLE B1

$300 BASE, 6% DISCOUNT RATE, INDICATED INFLATION RATE

1 YR	2 BASE	3 COST	4 BENEFIT	5 COST(RPV)	6 BENEFIT(RPV)	INFLATION RATE
0	$300.00	$ 7.50	$ 165.00	$ 7.50	$ 165.00	0.0%
1	300.00	7.50	165.00	7.08	155.66	0.0
2	300.00	7.50	165.00	6.67	146.85	0.0
3	300.00	7.50	165.00	6.30	138.54	0.0
4	300.00	7.50	165.00	5.94	130.70	0.0
5	300.00	7.50	165.00	5.60	123.30	0.0
10	300.00	7.50	165.00	4.19	92.14	0.0
15	300.00	7.50	165.00	3.13	68.85	0.0
20	300.00	7.50	165.00	2.34	51.45	0.0
30	300.00	7.50	165.00	1.31	28.73	0.0
40	300.00	7.50	165.00	0.73	16.04	0.0
0	$300.00	$ 7.50	$ 165.00	$ 7.50	$ 165.00	1.5%
1	304.50	7.95	167.47	7.61	160.37	1.5
2	309.07	8.41	169.99	7.71	155.86	1.5
3	313.70	8.87	172.54	7.79	151.48	1.5
4	318.41	9.34	175.12	7.85	147.23	1.5
5	323.18	9.82	177.75	7.90	143.09	1.5
10	348.16	12.32	191.49	7.98	124.09	1.5
15	375.06	15.01	206.29	7.83	107.62	1.5
20	404.05	17.90	222.23	7.52	93.33	1.5
30	468.91	24.39	257.90	6.64	70.19	1.5
40	544.19	31.92	299.30	5.63	52.79	1.5
0	$300.00	$ 7.50	$ 165.00	$ 7.50	$ 165.00	3.0%
1	309.00	8.40	169.95	8.16	165.14	3.0
2	318.27	9.33	175.05	8.81	165.28	3.0
3	327.82	10.28	180.30	9.43	165.42	3.0
4	337.65	11.20	185.71	9.98	165.56	3.0
5	347.78	12.28	191.28	10.64	165.70	3.0
10	403.18	17.82	221.75	12.97	166.41	3.0
15	467.39	24.20	257.06	15.73	167.11	3.0
20	541.83	31.68	298.01	17.84	167.83	3.0
30	728.18	50.32	400.50	21.27	169.29	3.0
40	978.62	75.36	538.24	23.90	170.70	3.0
0	$300.00	$ 7.50	$ 165.00	$ 7.50	$ 165.00	6.0%
1	318.00	9.30	174.90	9.30	174.90	6.0
2	337.08	11.21	185.39	11.21	185.39	6.0
3	357.30	13.23	196.52	13.23	196.52	6.0
4	378.74	15.37	208.31	15.37	208.31	6.0
5	401.47	17.65	220.81	17.65	220.81	6.0
10	537.25	31.22	295.49	31.22	295.49	6.0
15	718.97	49.40	395.43	49.40	395.43	6.0
20	962.14	73.71	529.18	73.71	529.18	6.0
30	1723.05	149.80	947.68	149.80	947.68	6.0
40	3085.72	286.07	1697.15	286.07	1697.15	6.0

TABLE B2
$450 BASE, 6% DISCOUNT RATE, INDICATED INFLATION RATE

1	2	3	4	5	6	
YR	BASE	COST	BENEFIT	COST(RPV)	BENEFIT(RPV)	INFLATION RATE
0	$450.00	$ 22.50	$ 247.50	$ 22.50	$ 247.50	0.0%
1	450.00	22.50	247.50	21.23	233.49	0.0
2	450.00	22.50	247.50	20.02	220.27	0.0
3	450.00	22.50	247.50	18.89	207.81	0.0
4	450.00	22.50	247.50	17.82	196.04	0.0
5	450.00	22.50	247.50	16.81	184.95	0.0
10	450.00	22.50	247.50	12.56	138.20	0.0
15	450.00	22.50	247.50	9.39	101.27	0.0
20	450.00	22.50	247.50	7.02	77.17	0.0
30	450.00	22.50	247.50	3.92	43.09	0.0
40	450.00	22.50	247.50	2.19	24.06	0.0
0	$450.00	$ 22.50	$ 247.50	$ 22.50	$ 247.50	1.5%
1	456.75	23.17	251.21	22.19	240.55	1.5
2	463.60	23.86	254.93	21.88	233.79	1.5
3	470.55	24.56	258.80	21.56	227.22	1.5
4	477.61	25.26	262.69	21.24	220.84	1.5
5	484.78	25.98	266.63	20.91	214.64	1.5
10	522.24	29.72	287.23	19.26	186.14	1.5
15	562.60	33.76	309.43	17.61	161.42	1.5
20	606.07	38.11	333.34	16.00	139.99	1.5
30	703.37	47.84	386.85	13.02	105.28	1.5
40	816.28	59.13	448.96	10.43	79.18	1.5
0	$450.00	$ 22.50	$ 247.50	$ 22.50	$ 247.50	3.0
1	463.50	23.85	254.93	23.18	247.72	3.0
2	477.40	25.24	262.57	23.83	247.92	3.0
3	491.73	26.67	270.45	24.47	248.13	3.0
4	506.48	28.15	278.56	25.10	248.34	3.0
5	521.67	29.67	286.92	25.70	248.56	3.0
10	604.76	37.98	332.62	28.50	249.61	3.0
15	701.09	47.61	385.60	30.95	250.66	3.0
20	812.75	58.78	447.01	33.10	251.74	3.0
30	1092.27	86.73	600.75	36.65	253.89	3.0
40	1467.93	124.29	807.36	39.42	256.06	3.0
0	$450.00	$ 22.50	$ 247.50	$ 22.50	$ 247.50	6.0%
1	477.00	25.20	262.35	25.20	262.35	6.0
2	505.62	28.06	278.09	28.06	278.09	6.0
3	535.96	31.10	294.78	31.10	294.78	6.0
4	568.11	34.31	312.46	34.31	312.46	6.0
5	602.20	37.72	331.21	37.72	331.21	6.0
10	805.88	58.09	443.23	58.09	443.23	6.0
15	1078.45	85.34	593.15	85.34	593.15	6.0
20	1443.21	121.82	793.76	121.82	793.76	6.0
30	2584.58	235.96	1421.52	235.96	1421.52	6.0
40	4628.59	440.36	2545.72	440.36	2545.72	6.0

APPENDIX C

Assuming that money can be deposited, or otherwise invested at some annual rate of interest, i, then an initial amount of money, A_o, will grow to an amount, P, in n years, as given by the compound interest formula:

$$P = A_o (1 + i)^n \qquad \text{EQ. C1}$$

This equation can be rewritten as:

$$A_o = \frac{P}{(1 + i)^n} \qquad \text{EQ. C2}$$

which is, by definition, the present value of P.

Assume, now, that inflation occurs at an annual rate, r, and that money is hoarded (not invested). This year a given sum of money, A_o, will purchase an amount of goods worth A_o but by next year the same amount of money will have decreased in purchasing power to some lesser amount P. This relationship can be expressed in the same manner as EQ. C2:

$$P = \frac{A_o}{(1 + r)^n}$$

where P represents the command over goods, or purchasing power, of A_o. Rewritten, this becomes:

$$A_o = P (1 + r)^n \qquad \text{EQ. C3}$$

where A_o is the amount of money required at present in order to achieve a command over goods, P (i. e. , the amount of money required in any future year in order to maintain the purchasing power of A_o).

Assuming now that an amount of money, A_o, is invested at a rate of interest, i, and inflation occurs at a rate, r, then the amount of money required at present in order to maintain a given command, P, over goods in the future can be determined by combining EQ. C2 and EQ. C3 and is:

$$A_o = P \frac{(1 + r)^n}{(1 + i)^n} \qquad \text{EQ. C4}$$

EQ. C4 can be rewritten to demonstrate the command over goods in the future resulting from a given initial amount of money, or an initial investment, as:

$$P = A_o \frac{(1 + i)^n}{(1 + r)^n} \qquad \text{EQ. C5}$$

EQ. C4 and EQ.C5 represent the discrete case for annual rates of i and r with annual compounding. In the continuous case, EQ. C4 becomes $A_o = P\, e^{(r-i)n}$ and EQ. C5 becomes $P = A_o\, e^{(i-r)n}$. The continuous equations would be valid approximations to the discrete equations for very small (e. g., daily) values of i, continuous (e. g., daily) compounding of interest, and large values of n (e. g., n = 365) for daily compounding over a year.

Although the rate of inflation is computed monthly and given in annual rates, it is in reality determined by a continuous process. Likewise, although returns on investments are not normally compounded continuously, the compounding approaches the continuous case for frequent compounding (e. g., monthly or more often). Since the rate of inflation is a continuous, though erratic, process and the rate of return on investments can be considered essentially a continuous process, in many cases, the combined effects of inflation and a return on investment could be easily determined from the continuous approximations of EQ. C4 and EQ. C5.

The effects of inflation are reflected in the purchasing power of consumer's money through changes in the CPI, which is a measure of the inflation rate. Even though the rate of inflation is determined by a continuous process, the CPI is determined monthly and

adjustments to the SBP are made only when the CPI increases to a value, over a 3 month period of time, of at least 3% above a level determined as of the immediately previous CPI adjustment. Existing legislation requires CPI adjustments to the SBP to be made at a level 1% above the level determined by CPI increases; thus, the minimum adjustment to the SBP will be a 4% increase in costs and benefits and these adjustments will be made no more often than once every 3 months. Since CPI increases have, historically increased at a rate of approximately 2.8% since 1930 (see APPENDIX A) it seems reasonable to assume that, over a long period of time, CPI adjustments will be made to the SBP at intervals long enough to make the assumptions regarding the continuous equations, which approximate EQ. C4 and EQ. C5, invalid. Thus, for purposes of this paper, the discrete EQsC4 and C5 are utilized where PV (the present value discount factor) and CPI (the annual rate of inflation) are substituted for i and r respectively to yield the equations:

$$A_o = P\frac{(1 + CPI)^n}{(1 + PV)^n} \qquad \underline{EQ.C6}$$

$$P = A_o\frac{(1 + PV)^n}{(1 + CPI)^n} \qquad \underline{EQ.C7}$$

EQ. C6 can be rewritten in the form:

$$A_o = P / \left(1 + \frac{PV - CPI}{1 + CPI}\right)$$

or equivalently,

$$A_o = P / (1 + PPV) \qquad \underline{EQ.C8}$$

where PPV of EQC8 is defined as the present purchasing value of money factor, which determines the present amount of money required in order to maintain a command over goods of P, and A_o of EQ. C8 is defined as the real present value (RPV) of P.

COMPUTER PROGRAM 1

```
   THIS PROGRAM COMPUTES COSTS , BENEFITS , AND THE
 COST/BENEFIT RATIO FOR THE SBP.

    DIMENSION PD(99),BENY(99)
    DOUBLE PRECISION C,DM,DF,EB,EV,REM,REF,EFI,EFP,EFS,
   1EFT,BENA,BENB,BENT,DFAA,DFTT,ENFT,REFE,REFR,RSBP

 VARIABLE NAMES FOR THE INPUT DATA FOLLOW.
   PD   = DEATH RATE
   SS   = SOCIAL SECURITY OFFSET
   BASE = SBP ELECTED BASE AMOUNT
   PV   = PRESENT VALUE DISCOUNT RATE
   CPI  = ANNUAL CPI RATE OF INCREASE

    READ (5,100)((PD(I)),I=27,99)
100 FORMAT (10F8.6)
    READ (5,200)SS
200 FORMAT (F7.2)
    DO 900 II=1,5
    READ (5,300)BASE,PV,CPI
300 FORMAT (F5.1,5X,F5.3,5X,F6.4)

 VARIABLE NAMES FOR INITIALIZED DATA FOLLOW.
   SAPV = SEMI-ANNUAL P.V. RATE
   ANSS = ANNUAL SOCIAL SECURITY OFFSET
   M    = AGE OF RETIREE IN YEAR OF RETIREMENT
   MBEN = AGE OF POTENTIAL BENEFICIARY
   BENT = TOTAL BENEFIT RECEIVED BY ELIGIBLE POPULATION
          FOR YEAR OF RETIREE'S DEATH
   EB   = TOTAL ACCUMULATED BENEFIT RECEIVED SINCE
          RETIREE'S DEATH
   CPVT = ACCUMULATED COST PAID BY RETIREE UNTIL PRESENT
          YEAR
   EV   = ACCUMULATED COST PAID BY RETIREE THROUGH PRESENT
          YEAR
   REM  = REMAINING PORTION OF POPULATION OF RETIREES
   REFR = REMAINING PORTION OF POPULATION OF BENEFICIARIES
   ENFT = TOTAL NUMBER OF BENEFICIARIES THAT PREDECEASED
          APPLICABLE RETIREE
   K    = NUMBER OF YEARS RETIREE HAS LIVED SINCE RETIRE-
          MENT
   KK   = NUMBER OF YEARS BENEFICIARY HAS LIVED SINCE
          RETIREMENT

    SAPV = PV/2.
    ANSS = 12. * SS

   THE 800 LOOP PERFORMS CALCULATIONS FOR EACH POPULATION
 AT A PARTICULAR RETIREMENT AGE.

    DO 800 M=37,65
    MBEN = M - 2
    BENT = 0.0
    REM  = 1.0
    REFR = 1.0
    EV   = 0.0
    CPVT = 0.0
    K    = 0
    KK   = 0
    EB   = 0.0
    ENFT = 0.0

   THE 700 LOOP PERFORMS CALCULATIONS FROM THE YEAR OF
 RETIREMENT THROUGH THE YEAR OF THE RETIREE'S DEATH.

   VARIABLE NAMES FOR THE 700 LOOP , NOT PREVIOUSLY
 DEFINED , FOLLOW.
   I    = BENEFICIARY'S AGE FOR APPLICABLE DEATH RATE
   J    = NUMBER OF SEMI-ANNUAL PERIODS SINCE RETIREMENT
   B    = TIME VALUE OF MONEY FACTOR DUE TO CPI RATE
```

C = TIME VALUE OF MONEY FACTOR DUE TO P.V. RATE
BASS = ACTUAL BASE AMOUNT AS ADJUSTED BY THE CPI RATE
CPVA = PRESENT VALUE OF ANNUAL COST TO RETIREE
CPVS = SEMI-ANNUAL COST TO RETIREE
BENY = ANNUAL BENEFIT FOR YEAR OF RETIREE'S DEATH
DM = PORTION OF RETIRED POPULATION DYING THIS YEAR
CT = LIFETIME COSTS PAID BY RETIREE'S DYING THIS YEAR
EV = TOTAL COSTS PAID BY DECEASED PORTION OF RETIRED POPULATION
REM = PORTION OF RETIRED POPULATION STILL LIVING
DFTT = PORTION OF BENEFICIARIES DYING THIS YEAR
EFP = RATIO OF POPULATION OF RETIREES DYING THIS YEAR THAT WOULD LEAVE ELIGIBLE BENEFICIARIES IF ALL POTENTIAL BENEFICIARIES WERE STILL ALIVE
ENF = PORTION OF POPULATION OF BENEFICIARIES THAT PREDECEASE APPLICABLE RETIREE THIS YEAR
ENFT = TOTAL PORTION OF POPULATION OF BENEFICIARIES THAT ARE INELIGIBLE FOR BENEFITS
EFS = PORTION OF BENEFICIARIES THAT BECOME ELIGIBLE TO RECEIVE BENEFITS THIS YEAR
EFI = PORTION OF BENEFICIARIES THAT BECOME ELIGIBLE TO RECEIVE BENEFITS THIS YEAR AND ALSO DIE THIS YEAR
EFT = PORTION OF BENEFICIARIES THAT BECOME ELIGIBLE TO RECEIVE BENEFITS THIS YEAR AND CONTINUE ELIGIBILITY THROUGHOUT THIS YEAR
BENA = TOTAL BENEFIT RECEIVED BY ELIGIBLE POPULATION THAT DIES THIS YEAR
BENB = TOTAL BENEFIT RECEIVED BY ELIGIBLE POPULATION THAT DRAWS BENEFITS FOR THE ENTIRE YEAR
MA = AGE OF RETIREE

```
 DO 700  MA=M,99
 I     =  MA - 7
 J     =  2*K + 1
 B     =  (1. + CPI)**K
 C     =  (1. + SAPV)**J
 BASS  =  BASE * B
 CPVA  =  (90. + 1.2*(BASS - 300.)) * B/C
 CPVS  =  0.5 * CPVA
 CPVT  =  CPVT + CPVA
 IF (MA.EQ.M.AND.I.LT.57) BENY(I) = 6.6*BASS
 IF (MA.EQ.M.AND.I.GE.57) BENY(I)= 6.6*BASS-ANSS
 DM    =  PD(MA) * REM
 CT    =  DM * (CPVS + CPVT)
 EV    =  EV + CT
 REM   =  REM - DM
 DFTT  =  PD(I)*REFR
 REFR  =  REFR - DFTT
 EFP   =  PD(MA)*(REM/REFR)
 ENF   =  (1.-EFP)*DM
 ENFT  =  ENFT + ENF
 REFE  =  REFR - ENFT
 EFS   =  EFP*REM*REFE/REFR
 EFI   =  EFS * DFTT/REFR
 EFT   =  EFS-EFI
 BENA  =  .25*BENY(I)*EFI
 BENB  =  .5*BENY(I)*EFT
 BENT  =  BENA + BENB
 I     =  I + 1
 KK    =  KK + 1
```

THE 600 LOOP PERFORMS CALCULATIONS FROM THE AGE OF THE BENEFICIARY IN THE YEAR FOLLOWING THE RETIREE'S DEATH THROUGH THE YEAR OF THE BENEFICIARY'S DEATH.

VARIABLE NAMES FOR THE 600 LOOP ,NOT PREVIOUSLY DEFINED , FOLLOW.

JJ = NUMBER OF SEMI-ANNUAL PERIODS SINCE RETIREMENT
AA = PRESENT VALUE OF MONEY FACTOR APPLICABLE

COMPUTER PROGRAM 1 CONTINUED

```
   DFAA = PORTION OF ELIGIBLE POPULATION OF BENEFICIARIES
          DYING THIS YEAR

    DO 600 L=I,99
    JJ   =  2*KK+1
    AA   =  (1. + CPI)**KK/(1. + SAPV)**JJ
    BASS =  BASE*(1. + CPI)**KK
    IF (MA.EQ.M.AND.L.LT.57) BENY(L)=6.6*BASS*AA
    IF (MA.EQ.M.AND.L.GE.57) BENY(L)=(6.6*BASS-ANSS)*AA
    DFAA =  PD(L)*EFT
    EFT  =  EFT - DFAA
    BENA =  .5*BENY(L) * DFAA
    BENB =  BENY(L)*EFT
    BENT =  BENT + BENA + BENB
    KK   =  KK + 1
600 CONTINUE
    EB   =  EB + BENT
    K    =  K + 1
700 CONTINUE

   RSBP = SBP EXPECTED LIFETIME COST/BENEFIT RATIO

    RSBP =  EV / EB
    WRITE (6,750)M,EV,EB,RSBP,BASE,CPI
750 FORMAT (5X,I3,5X,F12.2,5X,F12.2,5X,F7.3,5X,F5.1,5X,
   1F6.3)
800 CONTINUE
900 CONTINUE
    STOP
    END
```

```
                 COMPUTER PROGRAM 2

   THIS PROGRAM COMPUTES EXPECTED LIFETIME COSTS,BENEFITS,
 AND THE COST/BENEFIT RATIO FOR ORDINARY LIFE AND LEVEL
 PREMIUM,DECREASING TERM LIFE INSURANCE.

    DIMENSION PD(99),RDT(65),ROL(65),EYL(99)
    DOUBLE PRECISION REM,ECOL,ECDT,EBOL,EBDT,
   1DM,COL,CDT,DF,TBDT,RTOL,RTDT,TBOL,REF

 VARIABLE NAMES FOR THE INPUT DATA FOLLOW.
   PD   = DEATH RATE
   ROL  = ANNUAL PREMIUM FOR ORDINARY LIFE INSURANCE
   RDT  = ANNUAL PREMIUM FOR DECREASING TERM INSURANCE
   EYL  = YEARS OF LIFE EXPECTANCY
   BASE = SBP ELECTED BASE AMOUNT
   CPI  = ANNUAL CPI RATE OF INCREASE
   PV   = PRESENT VALUE DISCOUNT RATE

    READ (5,100)((PD(I)),I=27,99)
100 FORMAT (10F3.6)
    READ (5,200)((ROL(M)),M=37,65)
200 FORMAT (10F8.2)
    READ (5,300)((RDT(M)),M=37,65)
300 FORMAT (10F8.2)
    READ (5,400)((EYL(I)),I=27,99)
400 FORMAT (10F8.2)
    DO 900 IA=1,6
    READ (5,500) BASE,PV,CPI
500 FORMAT (F5.1,5X,F5.3,5X,F6.4)

 VARIABLE NAMES FOR INITIALIZED DATA FOLLOW.
   SAPV = SEMI-ANNUAL P.V. RATE
   M    = AGE OF RETIREE IN YEAR OF RETIREMENT
   REM  = REMAINING PORTION OF POPULATION OF RETIREES
   ECOL = CUMULATIVE COST PAID BY RETIREE FOR ORDINARY
          LIFE INSURANCE
   ECDT = CUMULATIVE COST PAID BY RETIREE FOR DECREASING
          TERM INSURANCE
   COLT = CUMULATIVE COST OF ORDINARY LIFE INSURANCE
          PAYABLE BY RETIREE
   CDTT = CUMULATIVE COST OF DECREASING TERM INSURANCE
          PAYABLE BY RETIREE
   K    = NUMBER OF YEARS RETIREE HAS LIVED SINCE RETIRE-
          MENT
   MBEN = AGE OF BENEFICIARY IN YEAR OF RETIREMENT
   EBOL = CUMULATIVE BENEFIT RECEIVED BY BENEFICIARY FROM
          ORDINARY LIFE INSURANCE
   EBDT = CUMULATIVE BENEFIT RECEIVED BY BENEFICIARY FROM
          DECREASING TERM INSURANCE

   THE 800 LOOP PERFORMS CALCULATIONS FOR EACH POPULATION
 OF A PARTICULAR RETIREMENT AGE.

    SAPV = PV / 2.
    DO 800 M=37,65
    REM  = 1.0
    ECOL = 0.0
    ECDT = 0.0
    COLT = 0.0
    CDTT = 0.0
    K    = 0
    MBEN = M - 2
    EBOL = 0.0
    EBDT = 0.0

   THE 700 LOOP PERFORMS CALCULATIONS FROM THE YEAR OF
 RETIREMENT THROUGH THE YEAR OF THE RETIREE'S DEATH.

   VARIABLE NAMES FOR THE 700 LOOP , NOT PREVIOUSLY
 DEFINED , FOLLOW.
   MA   = CURRENT AGE OF RETIREE
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    L    = BENEFICIARY'S AGE FOR APPLICABLE DEATH RATE
    KK   = NUMBER OF SEMI-ANNUAL PERIODS SINCE RETIREMENT
    BB   = TIME VALUE OF MONEY FACTOR DUE TO CPI RATE
    CC   = TIME VALUE OF MONEY FACTOR DUE TO P.V. RATE
    COLA = PRESENT VALUE OF ANNUAL COST OF ORDINARY LIFE
           INSURANCE PER $1000 POLICY
    COLS = SEMI-ANNUAL COST OF ORDINARY LIFE INSURANCE
    CDTA = PRESENT VALUE OF ANNUAL COST OF DECREASING TERM
           INSURANCE PER $1000 POLICY
    DM   = PORTION OF RETIRED POPULATION DYING THIS YEAR
    COL  = LIFETIME COSTS PAID BY RETIREE'S DYING THIS YEAR
           FOR ORDINARY LIFE INSURANCE
    CDT  = LIFETIME COSTS PAID BY RETIREE'S DYING THIS YEAR
           FOR DECREASING TERM INSURANCE
    BOL  = POLICY AMOUNT OF ORDINARY LIFE INSURANCE
    BDT  = POLICY AMOUNT OF DECREASING TERM INSURANCE
    REF  = POPULATION OF BENEFICIARIES BECOMING ELIGIBLE
           FOR BENEFITS THIS YEAR
    BOI  = ANNUAL FRACTION OF TOTAL BENEFIT TO BE RECEIVED
           FROM ORDINARY LIFE POLICY
    DTI  = ANNUAL FRACTION OF TOTAL BENEFIT TO BE RECEIVED
           FROM DECREASING TERM POLICY
    N    = NUMBER OF YEARS SINCE INITIALLY ELIGIBLE FOR
           BENEFIT

     DO 700 MA=M,99
     L    = MA - 7
     KK   = 2*K + 1
     BB   = (1. + CPI)**K
     CC   = (1. + SAPV)**KK
     COLA = ROL(M)*BB/CC
     COLS = 0.5 * COLA
     IF (MA.LE.63) CDTA = RDT(M)*BB/CC
     IF (MA.GT.63) CDTA = 0.0
     CDTS = 0.5 * CDTA
     DM   = PD(MA) * REM
     COL  = DM * (COLS + COLT)
     CDT  = DM * (CDTS + CDTT)
     ECOL = ECOL + COL
     ECDT = ECDT + CDT
     REM  = REM - DM
     COLT = COLT + COLA
     CDTT = CDTT + CDTA
     BOL  = 1000.0
     IF (MA.LE.63) BDT = 1000.0
     IF (MA.GT.63) BDT = 0.0
     REF  = DM
     BOI  = 0.0
     DTI  = 0.0
     N    = 0

    THE 600 LOOP PERFORMS CALCULATIONS FROM THE YEAR OF THE
APPLICABLE RETIREE'S DEATH THROUGH THE YEAR OF DEATH OF
THE BENEFICIARY.

    VARIABLE NAMES FOR THE 600 LOOP ,NOT PREVIOUSLY
DEFINED , FOLLOW.
    MB   = BENEFICIARY'S AGE FOR APPLICABLE DEATH RATE
    DF   = PORTION OF POPULATION OF BENEFICIARIES DYING
           THIS YEAR
    I    = NUMBER OF YEARS BENEFICIARY HAS LIVED SINCE
           RETIREMENT
    IT   = NUMBER OF SEMI-ANNUAL PERIODS SINCE RETIREMENT
    NN   = NUMBER OF SEMI-ANNUAL PERIODS SINCE RETIREE'S
           DEATH
    A    = INTEREST RETURN FACTOR FOR INVESTED INSURANCE
           POLICY PROCEEDS
    B    = TIME VALUE OF MONEY FACTOR DUE TO CPI RATE
    C    = TIME VALUE OF MONEY FACTOR DUE TO P.V. RATE
    BOIS = ANNUAL BENEFIT PLUS INTEREST RECEIVED FROM
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COMPUTER PROGRAM 2 CONTINUED

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        ORDINARY LIFE INSURANCE BY BENEFICIARIES LIVING
        ENTIRE CURRENT YEAR
 TBOL = TOTAL BENEFIT RECEIVED BY THE POPULATION OF
        BENEFICIARIES THIS YEAR FROM ORDINARY LIFE
        INSURANCE
 DTIS = ANNUAL BENEFIT PLUS INTEREST RECEIVED FROM
        DECREASING TERM INSURANCE BY BENEFICIARIES
        LIVING ENTIRE CURRENT YEAR
 TBDT = TOTAL BENEFIT RECEIVED BY THE POPULATION OF
        BENEFICIARIES THIS YEAR FROM DECREASING TERM
        INSURANCE

      DO 600 MB=L,99
      DF   = PD(MB) * REF
      REF  = REF - DF
      I    = K + N
      IT   = 2*I + 1
      NN   = 2*N + 1
      A    = (1. + SAPV)**NN
      B    = (1. + CPI)**I
      C    = (1. + SAPV)**IT
      BOI  = BOL/EYL(L)
      BOL  = BOL - BOI
      BOIS = BOI/2. + (BOI/2.)*A
      TBOL = (BOIS*REF + (BOIS + BOL*A)*DF)*B/C
      EBOL = EBOL + TBOL
      DTI  = BDT/EYL(L)
      BDT  = BDT - DTI
      DTIS = DTI/2. + (DTI/2.)*A
      TBDT = (DTIS*REF + (DTIS + BDT*A)*DF)*B/C
      EBDT = EBDT + TBDT
      N    = N + 1
  600 CONTINUE
      K    = K + 1
  700 CONTINUE

 RTOL = EXPECTED LIFETIME COST/BENEFIT RATIO OF ORDINARY
        LIFE INSURANCE
 RTDT = EXPECTED LIFETIME COST/BENEFIT RATIO OF
        DECREASING TERM INSURANCE

      RTOL = ECOL /EBOL
      IF (EBDT.GT.1.) RTDT = ECDT / EBDT
      IF (EBDT.LE.1.) RTDT = 0.0
      WRITE (6,720)M,ECOL,EBOL,RTOL
  720 FORMAT ('      FOR RETIREMENT AGE = ',I2,' ECOL = ',F10
     1',F10.4,' RTOL = ',F8.4)
      WRITE (6,725)MBEN,ECDT,EBDT,RTDT
  725 FORMAT ('          WIFES AGE = ',I2,' ECDT = ',F10.4,' EB
     1,' RTDT = ',F8.4)
  800 CONTINUE
      WRITE (6,810)BASE,PV,CPI
  810 FORMAT (20X,'FOR BASE = ',F5.1,5X,'PV = ',F5.3,5X,'CPI
  900 CONTINUE
      STOP
      END
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